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CONTENTS

(Vol. V, Part I)

January, 1935.

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ORIGINAL ARTICLES

NOTES

LIST OF ILLUSTRATIONS

CONTENTS

(Vol. V, PART III)

May, 1935

The Editorial Committee of the Imperial Council of Agricultural Research India, takes no responsibility for the opinions expressed in this Journal

ORIGINAL ARTICLES

NOTES

A

LIST OF ILLUSTRATIONS.

CONTENTS

(VOL. V, PART IV)

July, 1935

The Editorial Committee of the Imperial Council of Agricultural Research, India, takes no responsibility for the opinions expressed in this Journal

ORIGINAL ARTICLES

SELECTED ARTICLES

A

NOTES

LIST OF ILLUSTRATIONS

CONTENTS

(Vol. V, Part V)

September, 1935

The Editorial Committee of the Imperial Council of Agricultural Research, India, takes no responsibility for the opinions expressed in this Journal

ORIGINAL ARTICLES

SELECTED ARTICLES

NOTES

REVIEW

LIST OF ILLUSTRATIONS

CONTENTS

(Vol. V, Part VI)

November, 1935

The Editorial Committee of the Imperial Council of Agricultural Research, India, takes no responsibility for the opinions expressed in this Journal

ORIGINAL ARTICLES

LIST OF ILLUSTRATIONS

W. McRae, C. I. E., M. A, D. Sc.

ORIGINAL ARTICLES.

WILLIAM McRAE, C.I.E., M.A., D. Sc., F.L.S.

AN APPRECIATION

William McRae was born in Scotland in 1878, and received his education in the Edinburgh University from where he obtained the degrees of M.A. and B.Sc. He joined the Indian Agricultural Service in 1908 as a Supernumerary Mycologist at the Imperial Institute of Agricultural Research, Pusa. Soon after his appointment he was deputed to investigate the blister blight of tea, a disease which was doing a great deal of damage to the tea gardens in Darjeeling and published a bulletin indicating the lines on which its control was to be attempted.

In 1910, his services were placed at the disposal of the Government of Madras for employment in the local Agricultural Department which he served for 9 years, first as Government Mycologist and then as the Principal of the Agricultural College. During this period he organised the Mycological Section, developed the courses in Mycology for the students of the Agricultural College and caused campaigns to be conducted successfully against the bud-rot of palms in the Presidency He also described a new Phytophthora that was affecting the rubber plants

On the appointment of Dr E. J Butler, then Imperial Mycologist as Director of the Imperial Institute of Mycology, London, in 1920, McRae returned to Pusa as head of the Mycological Section of the Institute, which post he held till the end of his service except for short periods when he acted as Agricultural Adviser to the Government of India and as Agricultural Expert to the Imperial Council of Agricultural Research. The wilt disease of pigeon pea, the virus diseases of sugarcane and the foot-rot of betel vine are some of the important investigations carried out during this period. In addition to his duties as Imperial Mycologist, he held the post of Joint Director and eventually that of the Director of the Institute. His activities at Pusa were thus both scientific and administrative and the continued progress of the Institution is due, to a great measure, to his zeal and energy in both these directions. He made very useful contributions to Indian Mycology, no less than 21 papers of importance being to his credit for which he was awarded the degree of Doctor of Science by Edinburgh University. As a fitting recognition of his loyal services, the Government of India conferred upon him the honour of "C.I.E." in June 1934. His retirement from 23rd June, 1934, has been a distinct loss to the Department of Agriculture. [F.J.F.S.]

A NOTE ON THE PRODUCTION OF SUGAR DIRECTLY FROM CANE IN MODERN FACTORIES IN INDIA DURING THE SEASON 1933-34*

BY

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I. Number of factories operating

The remarkable expansion of the Sugar Industry in India, following on the grant of protection in 1932, is shown by the rate at which new factories have been built during the last two years. Prior to 1932-33 there were only 31 cane factories in operation. The first batch of 27 new factories (including one small experimental factory) was added during 1932-33. Another 65 new factories were built for working in 1933-34, making a total of 123 factories in India, an increase of almost 400 per cent. in two years.

The present note deals with 112 out of the 123 factories, as 7 factories were not ready in time for working, 8 failed to submit returns and one has been excluded as it is a small experimental factory for training of students, with a nominal and uncertain output.

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*It may be pointed out that the present note does not deal with the total production of sugar in India, but only with the portion produced by modern vacuum pan factories directly from cane. In addition to this, considerable quantities of sugar are manufactured from cane by small scale open pan factories and also refined from *gur* in vacuum pan refineries.

The following table shows the provincial distribution of factories working with cane during the last three seasons.

TABLE I.

Provincial distribution of factories working with cane.

Province	Number of cane factories operating					
	Season 1933-34				Season 1932-33	Season 1931-32
	New factories commencing operation for the first time in 1933-34	Factories commencing operation for the first time in 1932-33	Factories commencing operation prior to 1932-33	Total		
1. United Provinces .	27	19	14	60	33	14
2. Bihar and Orissa .	14	7	12	33	19	12
3. Punjab .	5	..	1	6	1	1
4. Madras .	2	..	2	4	2	2
5. Bombay .	4	..	1	5	1	2
6. Bengal .	2	..	..	2	..	..
7. Burma .	..	..	1	1	1	1
8. Indian States	1	..	..	1	..	..
Total .	55	26	31	112	57	32

It will be seen that the United Provinces registered the largest increase, the number of factories in the province being now more than half of the total number working in India during the season. For the first time two factories were built in Bengal and one in an Indian State. Burma is the only province in which no new factory was built during the year.

II. DURATION OF SEASON

Information regarding the duration of the cane crushing season under review is tabulated in the following tables. Table II shows the dates of starting of campaign by factories in each province. One new factory in the Punjab failed to supply information regarding the date of commencing operations. Hence Table II gives particulars for 111 out of 112 factories.

TABLE II.

Dates of commencement of cane crushing season 1933-34.

Date of starting	Number of factories started							
	United Provinces		Bihar and Orissa		All other provinces		Total for India season 1933-34	Total for India season 1932-33
	*New factories	Old factories	*New factories	Old factories	*New factories	Old factories		
4th-17th Oct. 1933 .	..	..	..	..	..	1	1	..
18th-31st Oct. 1933 .	1	..	..	..	..	..	1	3
1st-7th Nov. 1933 .	1	7	..	3	1	..	12	7
8th-14th Nov. 1933 .	1	8	..	7	..	..	16	9
15th-21st Nov. 1933 .	2	10	..	3	..	1	16	13
22nd-28th Nov. 1933 .	3	2	2	3	..	..	10	4
29th Nov. to 5th Dec. 1933. . . .	2	2	1	..	..	..	5	2
6th-12th Dec. 1933 .	..	1	..	..	..	..	1	5
13th-19th Dec. 1933 .	3	2	1	2	1	1	10	3
20th-26th Dec. 1933 .	1	..	1	..	2	..	4	1
27th Dec. 1933 to 10th Jan. 1934 . . .	5	..	2	..	..	..	7	7
11th-25th Jan. 1934 .	5	1	2	..	2	2	12	1
26th Jan. to 8th Feb. 1934. . . .	1	..	1	1	2	..	5	1
9th-22nd Feb. 1934 .	1	..	3	..	1	..	5	1
23rd Feb. to 9th March 1934. . . .	..	..	..	..	1	..	1	..
10th-23rd March 1934 .	1	..	..	..	3	..	4	..
24th March to 1st April 1934. . . .	..	..	1	..	..	..	1	..
Total .	27	33	14	19	13	5	111	57

* The term "new factories" denotes factories which commenced working for the first time during the season 1933-34, whilst "old factories" covers all other factories and includes the factories which were in operation prior to 1932 as well as the new ones which commenced operations during the season 1932-33. This nomenclature has been followed throughout the present note.

The crushing season 1933-34 commenced at approximately the same period as the previous year's season, but it is noteworthy that a factory in the Bombay Presidency established a record in early starting by commencing the campaign in the beginning of October.

The new factories were on the whole late in starting work. More than half of them were not ready for working till the end of December. One new factory in Bihar and Orissa commenced working only in the beginning of April.

The majority of old factories throughout India began their season between the beginning of November and the middle of December.

The dates of closing of the season are shown in Table III.

TABLE III.

Dates of closing of cane crushing season 1933-34.

Date of closing	Number of factories closed							
	United Provinces		Bihar and Orissa		All other provinces		Total for India 1933-34	Total for India 1932-33
	New factories	Old factories	New factories	Old factories	New factories	Old factories		
24th Feb. to 19th March 1934	3	..	..	1	2	..	6	..
20th-31st March 1934	6	2	..	..	1	..	9	2
1st-14th April 1934	1	5	2	1	1	1	11	4
15th-30th April 1934	10	16	5	5	..	1	37	8
1st-7th May 1934	4	5	2	2	3	..	16	7
8th-14th May 1934	1	4	..	3	2	1	11	10
15th-21st May 1934	2	..	1	2	1	..	6	9
22nd-28th May 1934	..	1	1	1	1	..	4	6
29th May to 4th June 1934	..	..	1	1	..	..	2	9
5th-11th June 1934	..	..	..	1	..	1	2	2
12th-18th June 1934	..	..	1	..	..	..	1	..
19th-30th June 1934	..	..	..	1	1	..	2	..
1st-15th July 1934	..	..	..	..	..	1	1	..
Total	27	33	13	18	12	5	108	57

The above table does not include 4 out of the 112 factories which worked during the season. Two of these (one new and one old) in Bihar and Orissa were so badly damaged by the earthquake of the 15th January 1934 that they could not resume work before the close of the season. A factory in Southern India was expected to continue working till September (the crushing season in this locality extending over 8 to 9 months in the year) and hence information regarding the date of closing of this factory also has

been excluded from the above table. The only other factory not included in the above table is one of the factories situated in the Punjab which failed to submit a complete return.

All the factories, both new and old, in the United Provinces had stopped working by the end of May 1934, whilst the crushing season in Bihar and Orissa lasted till the end of June, the latter province thus having an advantage of about a month. As against this, it may be mentioned that much of the cane crushed by the Bihar factories towards the end of the season was obtained from the earthquake affected areas, which was transported, in many cases, over long distances. This was done as a measure of relief to the cane-growers, as the recovery of sugar from such cane was generally low.

An old factory in Southern India continued working till the middle of July.

Statistics relating to the actual number of days (maximum, minimum and mean) for which factories worked during the season are summarised in Table IV. The figures in this table are obtained by making allowance for stoppages of crushing during the period intervening between the dates of commencement and closing of the season. For comparison figures for the previous year are also shown in the table.

TABLE IV.

Number of days of actual working of factories during cane crushing season 1933-34.

Particulars	Number of days of actual working							
	Season 1933-34				Season 1932-33			
	United Provinces	Bihar and Orissa	All other provinces	All India	United Provinces	Bihar and Orissa	All other provinces	All India
Old factories :—								
Maximum	166	164	208	208	182	184	175	184
Minimum	60	84	84	60	114	95	43	43
Mean	128	119	137	126	144	154	112	143
New factories :—								
Maximum	172	128	143	172	179	175	..	179
Minimum	20	30	25	20	39	51	..	39
Mean	93	86	57	84	129	142	..	132
All factories :—								
Maximum	172	164	208	208	182	184	175	184
Minimum	20	30	25	20	39	51	43	39
Mean	112	105	84	106	136	149	112	138

It will be seen that the maximum number of days worked by a factory during the season 1933-34 was 208 against 184 in the previous year. The average number of working days for the whole of India during the season is however only 106 as against 138 last year.

This reduction in the number of working days was due to various causes: delay in completion of new factories, damage and dislocation caused by the earthquake, and a poor cane crop in the Western parts of the United Provinces.

A further analysis of the duration of the cane-crushing season is given in Table V.

TABLE V.

Analysis of duration of crushing season.

Number of working days	United Provinces		Bihar and Orissa		All other provinces		All India 1933-34	All India 1932-33
	New factories	Old factories	New factories	Old factories	New factories	Old factories		
200 and over	..	..	..	..	..	1	1	..
175 to 199	..	..	..	..	..	1	1	6
150 to 174	4	7	..	5	..	..	16	20
125 to 149	1	13	1	5	1	..	21	12
100 to 124	4	9	4	3	1	1	22	10
75 to 99	10	3	6	4	1	2	26	2
50 to 74	5	1	..	1	2	..	9	3
25 to 49	1	..	2	..	6	..	9	2
24 and under	2	..	..	..	1	..	3	..
Total	27	33	13	18	12	5	108	55

It will be observed from this table that out of a total of 60 old and new factories in the United Provinces 11 worked for 150 to 174 days, 14 for 125 to 149, and 13 each for 100 to 124 and 75 to 99 days In the case of Bihar and Orissa, out of a total of 31 factories only 5 worked for 150 to 174 days, 6 for 125 to 149 days and 7 for 100 to 124 days. The comparative figures for the season 1932-33 show the longer duration of that season.

III. CAPACITIES OF FACTORIES

Data relating to capacities of factories expressed in terms of the total quantity of cane crushed during the season 1933-34 are summarised in the following table.

TABLE VI.

Quantity of cane crushed by factories during season 1933-34 **(*in tons*)**.

Particulars	Quantity of cane crushed during the season							
	Season 1933-34				Season 1932-33			
	United Provinces	Bihar and Orissa	All other provinces	All India	United Provinces	Bihar and Orissa	All other provinces	All India
Old factories :—								
Maximum . . .	149,222	117,480	81,122	149,222	126,152	179,579	94,400	179,579
Minimum . . .	3,330	10,592	6,262	3,330	10,079	12,418	3,260	3,260
Mean . . .	61,380	60,078	51,996	60,123	62,258	88,852	42,842	69,421
New factories :—								
Maximum . . .	97,973	106,242	38,551	106,242	79,880	103,197	..	103,197
Minimum . . .	6,033	2,500	511	511	1,150	25,737	..	1,150
Mean . . .	36,653	38,664	14,246	31,461	40,520	61,185	..	46,083
All factories :—								
Maximum . . .	149,222	117,480	81,122	149,222	126,152	179,579	94,400	179,579
Minimum . . .	3,330	2,500	511	511	1,150	12,418	3,260	1,150
Mean . . .	50,253	50,993	24,180	46,048	49,741	78,659	42,842	58,770

Figures for average capacities of factories calculated on the basis of tons of cane crushed per day of actual working during the season 1933-34 are tabulated below.

TABLE VII.

Average daily cane crushing capacities of factories during season 1933-34 (in tons).

Particulars	Average daily cane crushing capacity of factories							
	Season 1933-34				Season 1932-33			
	United Provinces	Bihar and Orissa	All other provinces	All India	United Provinces	Bihar and Orissa	All other provinces	All India
Old factories :—								
Maximum . . .	1,604	1,117	705	1,604	840	1,000	660	1,000
Minimum . . .	55	105	75	55	44	130	75	44
Mean . . .	495	504	380	487	430	570	380	485
New factories :—								
Maximum . . .	823	830	607	830	536	600	..	600
Minimum . . .	51	32	15	15	30	300	..	30
Mean . . .	407	447	348	415	350	430	.	500
All factories :—								
Maximum . . .	1,604	1,117	705	1,604	840	1,000	660	1,000
Minimum . . .	51	32	15	15	30	130	75	30
Mean . . .	462	484	365	458	400	500	380	440

IV. Effect of earthquake on the sugar industry

The severe earthquake which occurred on the 15th January 1934 caused very extensive damage to a number of sugar factories in Bihar. Of the 33 factories operating in the province all excepting about half a dozen had to be closed down temporarily after the earthquake, but fortunately the damage in most cases was not serious and work was resumed after a short time.

Eight factories were damaged seriously. Of these 3 are situated in the Champaran district, 2 in the Muzaffarpur district and 3 in the Darbhanga district. Two factories, one each in the districts of Muzaffarpur and Darbhanga, were damaged to such an extent that they could not be re-started during the season. The total number of deaths reported from six of the eight factories is 32, whilst a much larger number of men received injuries. The cost of repairing the damage caused to plant and buildings of sugar factories is estimated at Rs. 20 lakhs.

The effect of the earthquake on recovery of sugar and number of working days of the eight factories referred to above may be estimated from the following table which gives comparative figures for seasons 1932-33 and 1933-34.

Table VIII.

Effect of earthquake on factories which were severely damaged.

Factory	District	Recovery of sugar per cent. cane		Number of working days	
		1933-34	1932-33	1933-34	1932-33
No. 1	Champaran .	7·5	8·1	55	175
No. 2	Do. .	8·2	8·4	105	174
No. 3	Do. .	7·0	8·3	97	123
No. 4	Muzaffarpur	6·1	New factory	39	New factory
No. 5	Do. .	7·2	8·5	117	143
No. 6	Darbhanga .	8·4	8·7	131	177
No. 7	Do. .	8·4	8·7	56	174
No. 8	Do. .	8·6	8·7	90	173

The damage to standing cane crop was not serious but as a result of the breakdown of sugar factories and dislocation of rail and road transport, approximately 150 lakh maunds of cane had to be disposed of from the affected area. Of this quantity about 30 lakh maunds were taken up by the damaged factories after they were repaired and re-started and about 33 lakh maunds were consumed by the undamaged and slightly damaged factories in the earthquake affected area. The Cane Marketing Board started by Government was able to supply further 27 lakh maunds to factories outside this area. The balance of 60 lakh maunds was either crushed in bullock-driven mills for conversion into *gur* or was used as fodder.

The large quantity of cane, amounting to 90 lakh maunds, which was taken by factories from the earthquake area had a serious effect on their average recovery of sugar as, on account of difficulty of transport, most of this had considerably deteriorated before it could be crushed.

The damage to cane lands due to depositing of sand is not considered to be permanent or serious.

V. Sugar production

The production of sugar direct from cane in India totalled 453,965 tons during the season 1933-34 as against 290,177 tons during 1932-33. Out of the total production for 1933-34, the production of sugar by new factories amounted to 147,706 tons, whilst that of old factories was 306,259 tons. The production of old factories thus shows an increase of 5·5 per cent. over the previous year. The total increase in the output of sugar during the season 1933-34 over that of the previous year amounts to 163,788 tons.

The tables below show details of sugar production for factories in: (*a*) the United Provinces, (*b*) Bihar and Orissa, (*c*) Bombay, Madras, the Punjab, Bengal, Indian States and Burma and (*d*) India as a whole.

Table IX.

Production of sugar and molasses by factories in the United Provinces.

Particulars	1933-34			1932-33		
	Old factories	New factories	Total	Old factories	New factories	Total
Number of factories worked	33	27	60	14	19	33
Cane crushed (tons)	2,025,552	989,621	3,015,173	871,613	769,881	1,641,494
Sugar produced (tons)	186,586	87,188	273,774	73,998	66,346	140,344
Molasses produced (tons)	77,067	32,985	110,052	32,535	32,055	64,590
Recovery of sugar per cent. cane	9·21	8·81	9·08	8·48	8·61	8·55
Recovery of molasses per cent. cane	3·80	3·33	3·65	3·80	4·10	3·90

Table X

Production of sugar and molasses by factories in Bihar and Orissa.

Particulars	1933-34			1932-33		
	Old factories	New factories	Total	Old factories	New factories	Total
Number of factories worked	19	14	33	12	7	19
Cane crushed (tons)	1,141,477	541,304	1,682,781	1,066,230	428,297	1,494,527
Sugar produced (tons)	95,612	44,345	139,957	92,464	36,146	128,610
Molasses produced (tons)	40,553	20,472	61,025	41,196	16,672	57 868
Recovery of sugar per cent. cane	8·38	8·19	8·32	8·67	8·44	8·60
Recovery of molasses per cent. cane	3·55	3·78	3·62	3·90	3·90	3·90

TABLE XI.

Production of sugar and molasses by factories in Bombay, Madras, the Punjab, Bengal. Indian States and Burma.

Particulars	1933-34							1932-33.
	Old factories	New factories						Total
	Bombay, Madras, Punjab and Burma	Bombay	Punjab	Bengal	Madras and Indian States	Total new factories	Total old and new factories	
Number of factories worked	5	4	5	2	3	14	19	5
Cane crushed (tons)	259,980	52,889	37,588	76,655	32,307	199,439	459,419	214,210
Sugar produced (tons)	24,061	4,615	2,538	5,907	3,113	16,173	40,234	21,223
Molasses produced (tons)	10,293	2,283	1,316 (Estimated)	4,434	981	9,014	19,307	7,961
Recovery of sugar per cent. cane	9·26	8·72	6·75	7·70	9·63	8·11	8·75	9·90
Recovery of molasses per cent. cane	3·97	4·31	3·50	5·78	3·03	4·52	4·20	3·70

TABLE XII.

Total production of sugar and molasses by factories in India.

Particulars	1933-34 Old factories	1933-34 New factories	1933-34 Total	1932-33 Old factories	1932-33 New factories	1932-33 Total
Number of factories worked	57	55	112	31	26	57
Cane crushed (tons) . .	3,427,009	1,730,364	5,157,373	2,152,053	1,198,178	3,350,231
Sugar produced (tons) . .	306,259	147,706	453,965	187,685	102,492	290,177
Molasses produced (tons) . .	127,913	62,471	190,384	81,692	48,727	130,419
Recovery of sugar per cent. cane	8·90	8·53	8·80	8·72	8.55	8·66
Recovery of molasses per cent. cane . .	3·73	3·61	3·68	3·80	4·10	3·90

It will be observed that the quantities of cane crushed and sugar and molasses manufactured by the old factories in the United Provinces during 1933-34 were considerably larger than in 1932-33. But the new factories did not do as well as the old ones due to their lower extraction percentage and the shorter working period during the season. The working results of the new factories were inferior to those of the old factories in all the provinces during this season.

The all-India increase in the quantity of cane crushed was over 53 per cent. and in that of sugar and molasses produced 56 and 45 per cent. respectively.

An analysis of the average percentage recovery of sugar from cane for factories in different provinces during the season 1933-34 is given in Table XIII.

TABLE XIII.

Average percentage recovery of sugar from cane during season 1933-34.

Particulars	AVERAGE PERCENTAGE RECOVERY OF SUGAR FROM CANE							
	1933-34				1932-33			
	United Provinces	Bihar and Orissa	All other provinces	All India	United Provinces	Bihar and Orissa	All other provinces	All India
Old factories—								
Maximum . .	10·03	10·00	10·98	10·98	9·50	9·10	11·10	11·10
Minimum . .	6·87	6·27	7·10	6·27	7·00	6·10	6·90	6·10
Mean . .	9·21	8·38	9·26	8·93	8·48	8·67	9·90	8·72
New factories—								
Maximum . .	10·27	9·50	9·[illegible]0	10·27	9·20	9·20	..	9·20
Minimum . .	6·60	5·50	4·38	4·38	6·70	6·90	..	6 70
Mean . .	8·81	8·19	8·11	8·53	8·61	8·44	.	8·55
All factories—								
Maximum .	10·27	10·00	10·98	10·98	9·50	9·20	11·10	11 10
Minimum . .	6·60	5·50	4·38	4·38	6·70	6·10	6·90	6·10
Mean . .	9·08	8·32	8·75	8·80	8·55	8·60	9·90	8·66

The highest recovery for the season was 10·98 per cent., as against 11·10 per cent. during the preceding season. It is gratifying to note that in spite of a number of adverse circumstances the average extraction for the whole of India shows a slight increase, the figure being 8·80 for 1933-34 as against 8·66 for 1932-33.

The average extraction percentage shows a marked increase in the United Provinces, the figure being 9·08 per cent. as against 8·55 per cent. during the previous year. But in Bihar and Orissa the recovery has declined from 8·60 per cent. in 1932-33 to 8·32 per cent. in 1933-34, due to the havoc wrought by the last earthquake.

The recovery of sugar in new factories was on the whole satisfactory though the figures for a few factories were very low.

A further analysis of the recovery of sugar is given in Table XIV.

TABLE XIV.

Analysis of the recovery of sugar.

Recovery of sugar per cent. cane	United Provinces		Bihar and Orissa		All other provinces		All India	
	New	Old	New	Old	New	Old	1933-34	1932-33
11 and higher . .	..	..	..	..	..	..	..	1
10·5 to 10·9 . .	..	..	..	..	..	1	1	..
10 to 10·4 . . .	3	4	..	1	..	..	8	1
9·5 to 9·9 . . .	2	7	1	..	1	..	11	2
9 to 9·4 . . .	4	9	1	1	1	..	16	13
8·5 to 8·9 . . .	6	5	5	5	4	2	27	14
8 to 8·4 . .	4	3	2	5	1	..	15	14
7·5 to 7·9 . . .	5	2	1	3	..	..	11	6
7 to 7·4 . . .	..	2	1	3	..	2	8	2
6 to 6·9 . . .	2	1	2	1	3	..	9	4
5 to 5·9 . . .	..	..	1	..	2	..	3	..
Below 5 . . .	1	..	..	..	2	..	3	..
Total .	27	33	14	19	14	5	112	57

This table brings out clearly the improvement in recovery which has been a feature of the results obtained by factories in the United Provinces during the last season. As many as 9 factories in India had recoveries of 10 per cent. and over. Out of 112 factories in India 63 had recoveries of 8·5 per cent. and over. The factories which did best in Northern India were those situated in the eastern districts of the United Provinces and in the Saran district of Bihar. This area was not affected either by the earthquake or by the adverse natural conditions which prevailed in the West of the United Provinces, and the season in the area was therefore normal This shows that, given a normal crop, the factories are now in a position to show results well above those obtained in the past.

A review of the average percentage recovery of sugar from cane during the last five seasons is given in Table XV.

TABLE XV.

Recovery of sugar from cane during the five seasons 1929-30 to 1933-34.

Province	Recovery of sugar per cent. cane				
	1929-30	1930-31	1931-32	1932-33	1933-34
United Provinces . .	9·00	8·88	8·59	8·55	9·08
Bihar and Orissa . .	8·90	9·17	9·06	8·60	8·32
Other provinces . .	10·12	9·84	9·60	9·90	8·75
All India	9·07	9·09	8·89	8·66	8·80

In Table XVI have been brought together all-India figures for sugar production for the last eleven years. For comparison figures for recovery of sugar in Java have also been shown side by side.

TABLE XVI.

Production of sugar directly from cane in modern factories in India.

Season	No. of factories producing sugar direct from cane	Cane crushed (tons)	Sugar produced (tons)	Per cent. recovery for India	Per cent. recovery for Java
1923-24 . .	23	514,109	38,312	7·45	11·44
1924-25 . .	23	433,621	33,805	7·79	12·38
1925-26 . .	23	659,406	52,990	8·03	12·38
1926-27 . .	25	742,368	62,941	8·47	10·85
1927-28 . .	26	786,476	67,684	8·60	11·62
1928-29 . .	24	791,361	68,050	8·59	12·16
1929-30 . .	27	989,776	89,768	9·07	12·42
1930-31 . .	29	1,317,248	119,859	9.09	11·43
1931-32 . .	32	1,783,499	158,581	8·89	11·92
1932-33 . .	57	3,350,231	290,177	8 66	11·16
1933-34 . .	112	5,157,373	453,965	8·80	..

VI. CONCLUSION

The year under report was in several respects an unfortunate one for the cane sugar industry of India In the Western districts of the United Provinces, which comprise a large cane acreage, the crop was damaged by late rains and floods followed by an attack of certain insect pests. The demand for cane was, at the same time, increased as a number of new factories were built in this area. This resulted in a shortage of cane supply and in a deterioration of the quality of the raw material, which on the one hand shortened the working season and on the other lowered the recovery of sugar of these factories. In North Bihar, another important sugar producing tract, the disastrous earthquake in January 1934, caused serious damage to several factories particularly in the districts of Champaran, Muzaffarpur and Darbhanga. The diversion of cane crop to other factories was hampered by the dislocation of rail and road transport. Such cane from the earthquake area as could eventually be taken up by factories was so dry and stale that the average recovery of sugar was materially lowered.

It is a remarkable tribute to the inherent soundness of the industry that in the face of these adverse natural factors, and in spite of the fact that a record large number of new factories made their debut during the year, the all-India average recovery of sugar registered a distinct advance over the preceding year, which is most marked in the case of the United Provinces. The prospects for the coming season are favourable and it is expected that this improvement in recovery will be well maintained. Apart from a good crop and the improvements and extensions of plant, which have recently been made, the most hopeful feature consists in the realization, on the part of factory owners, of the supreme importance of employing only the best technical staff. The determining factor in the future, in regard to improvement in efficiency, will be the extent to which the importance of employing none but the best qualified technical staff is realized.

COMBINED REPORT ON THE INVESTIGATIONS INTO THE FINANCE, SOWINGS AND MARKETING OF CULTIVATOR'S COTTON IN THE TIRUPUR TRACT, MADRAS PRESIDENCY (SEASON 1932-33)

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CONTENTS

INTRODUCTORY

The investigations were carried out in two villages of the Tirupur tract, Madathupalayam and Andiyur, representative of the two important types of cottons, Cambodia and Karunganni, grown in the tract. (See Report on Marketing of Cottons at Tirupur.) Both the villages are situated in the Coimbatore district. The two varieties are cultivated in two distinct tracts, methods of cultivation varying in great detail, as the first is grown under irrigated conditions and the second as a rain-fed crop on the black cotton soil.

The villages.—Madathupalayam is in the Avanashi taluk of the Coimbatore district, situated about half a mile from Avanashi town, the headquarters of the taluk. It is really a hamlet of the village of Avanashi. The soil is a type of red loam of medium fertility. Andiyur is in Udamalpet taluk, situated about 5 miles west of Udamalpet town on the road to Pollachi. This village is typical of the black soil tract of the Coimbatore district. For further particulars about the villages see Appendix.

Periods of investigation.—The periods of investigation were as shown below:—

Sowing period:—

Madathupalayam	Andiyur
15th Sept. 1932 to 31st Oct. 1932	1st Nov. 1932 to 20th Dec. 1932.

Sowings are about a month earlier at Madathupalayam.

Harvest and marketing period.—The investigation was carried out in three different periods alternately in both villages, during the growth of the crop and disposal of produce. During the first period no picking was commenced, in the second about 50 per cent. of the produce was picked and in the third the harvest was over and all the produce was expected to be sold.

	Madathupalayam, 1933	Andiyur, 1933
1st period	1st Jan. to 15th Feb.	16th Feb. to 15th March
2nd period	16th March to 15th April	16th April to 15th May
3rd period	16th May to 15th July	16th July to 31st August

Season.—The season was fairly normal for both villages, except that it was a little unfavourable at Andiyur in the later part owing to absence of late rains and to the persistence of eastern winds (instead of the usual westerly) on account of which the yields were about 40 per cent. below normal.

Classification of cultivators investigated.—

Sowing period:—

Total number for both villages—113

	No. of cultivators	Percentage
Proprietors	82	72·6
Tenants	22	19·4
Proprietor-Tenants	9	8·0

Marketing period:—

Madathupalayam. Total number investigated—37

Proprietors	17	46·0
Tenants	13	35·0
Proprietor-Tenants	7	19·0
Small, having up to 3 acres of garden	10	27·0
Medium, 3 to 10 acres	22	59·5
Medium-large, 10 to 20 acres	4	10·8
Large, over 20 acres	1	2·7

Andiyur. Total number investigated—38

Proprietors	34	89·5
Tenants	*Nil*	..
Proprietor-Tenants	4	10·5
Small, having up to 15 acres of dry land	13	34·5
Medium, 15 to 50 acres	18	47 3
Medium-large, 50 to 100 acres	5	13·1
Large, over 100 acres	2	5·1

At Andiyur several cultivators possess some area of garden land in addition to the dry area. The classification has however been made on the dry land basis. Among the tenants, only one cultivates on the share system while all the others come under money-rent system, which works out on the average to Rs. 55 per acre of garden and Rs. 11 per acre of dry land.

Area and holdings:—

	Madathupalayam	Andiyur
Total No. of holdings recorded	37	38
Total area of holdings recorded in acres .	220	1.362
Average size of holding in acres . . .	6	36
Area under cotton in acres	168	979
Average cotton area per holding in acres . .	4·5	27
Percentage of the cotton area to the total area of holdings	76·4	72

The cotton areas may be sub-divided according to size as follows:—

	Madathupalayam No. of cultiva-tors	Madathupalayam Per cent.		Andiyur No. of cultiva-tors	Andiyur Per cent.
Small, up to 2 acres .	11	30	Up to 5 acres . .	6	15·8
Medium, 2 to 5 acres .	17	46	Five to 25 acres . .	21	55·3
Medium-large, 5 to 10 acres . . .	4	10·8	Twenty-five to 50 acres	4	10·3
Large, over 10 acres .	5	13·2	Over 50 acres . .	7	18·6
Total . .	37	100·0		38	100·0

Varieties of cotton grown.—Cambodia is the only variety grown at Madathupalayam village and at Andiyur about 90 per cent., of the area would be under Karunganni, the rest being under Uppam variety.

Sources of seed-supply.—The following statement shows the various sources of seed-supply:—

	Madathupalayam No. of cultiva-tors	Madathupalayam Per cent.	Andiyur No. of cultiva-tors	Andiyur Per cent.
Own seed	..	..	5	13·1
From traders . .	3	8	7	18·5
From ginning factory . .	3	8	14	37·0
Trading society (seed-farm seed) .	23	62·2	2	5·3
From another ryot	1	2·6	..	..
From the Agricultural Demonstrator (seed-farms)	7	19·0	1	2·6
From another tract (Tinnevelly) . .	..	..	9	23·5

At Andiyur a few ryots joined together and obtained seeds from a factory in the Tinnevelly district and distributed to others also. But they were of very

poor quality and on account of faulty germination much of the area had to be resown. The cultivators believe that seeds from a different tract would prove more vigorous and result in better crop and yield.

Production.—The approximate yield for each class of cotton area is given below:—

	Madathupalayam			Andiyur		
	Acres total	Yield in lb.	Yield per acre	Acres total	Yield in lb.	Yield per acre
Small . .	22	14,976	681	21	4,940	235
Medium .	51	49,322	987	288	62,920	220
Medium-large .	26	25,090	965	136	27,720	178
Large.	69	45,330	701	534	116,220	217
	168	134,718	..	979	211,800	..

COTTON GROWING—AGRICULTURAL ASPECT

Rotation of cropping.—At Madathupalayam a simple rotation of growing *ragi* (*Eleusine coracana*) and Cambodia cotton alternately, is followed. The duration of both combined extend just up to a year. *Ragi* gets the start in June and is harvested in September. Cotton is sown in October and comes to a finish in May. Major portion of the garden area is put down for this rotation while a small area may be sown to *cholam* (*Sorgrum vulgare*) or *cumbu* (*Pennisetum typhoideum*) or *tenai* (*Setaria italica*) and chillies and vegetables Sometimes *tenai* takes the place of *ragi*. *Cholam* is supposed to take greater nourishment from the soil than *ragi*, which is however preferred for consumption purposes. Cotton has a ready market, the Avanashi Cambodia being considered the best of the cottons by buyers in the Tirupur market. Formerly the rotation followed was as follows: *ragi*—tobacco—*cholam*—cotton in two years. Now tobacco has been eschewed as the well water is not quite suited and as it involves tedious operations before marketing. Cotton does not seem to thrive well after *cholam* and therefore this crop is confined to a very small area to augment the fodder supply.

At Andiyur, on the dry black soil cotton is grown year after year. The main variety is Karunganni though now and then a portion of the area may be sown with Uppam variety. Once in six years or so about a sixth of the total area will be put under Bengal gram (*Cicer arietinum*). Uppam variety is grown not only for a change but also because it stands adverse conditions better and gives better yield than Karunganni. The cultivators do realise the disadvantages of growing cotton over and over again, but it has become an economic necessity.

Factors governing the area under cotton.—The total area under cotton at Madathupalayam was 170 acres and at Andiyur 1,552 acres (area grown by all the cultivators investigated). In the latter village the area under Uppam variety was 18 per cent. The area under cotton showed an increase over that of last

year, in both villages. The tendency is to put down as much area under cotton as possible. This crop does not require operations of a tedious or expensive nature. The produce is disposed of at the ryots' doors. It is the best money fetching crop in both villages.

Preliminary cultivation and sowing.—At Madathupalayam, after the removal of *ragi* straw the field is ploughed twice or thrice as the case may be, manured and cotton sown. At Andiyur though the interval is much greater, from July to September, the majority give only two ploughings before sowing of cotton. In both villages country ploughs are used generally and there are more than a dozen iron ploughs possessed by the cultivators. Seeds are sown broadcast in both villages and one more light ploughing with the country plough covers the seed. Sowings are taken up only after sufficient rainfall has been received. At Madathupalayam subsequent rains till about the end of November are taken advantage of to save irrigations from wells and after this period regular irrigation starts by means of the bed system. At Andiyur most of the cultivators do not own cattle and for the operations of ploughing and sowing cattle and men are hired. Such labour is made available largely by migration of adjacent red soil cultivators with their cattle. Owing to this state of affairs cultivators have not taken up to drill-sowing though this has been shown to be more economical. Line dibbling for Cambodia cotton, though demonstrated to be advantageous in some respects, has not been taken up. This is said to involve much effort in working the land into ridges and furrows at a time when they have to hurry operations and also engaging of coolies specially for dibbling. Besides they are of opinion that by means of the furrow irrigation adequate supply of water may not be maintained for the plants as in the case of the bed system and the former becomes defective in the case of fields which are sloping and uneven.

Seed-rate.- With seed-farm Cambodia seed of good germinating capacity 12 to 15 lb. per acre is the rate when the seed is line-sown or dibbled on ridges. When broadcast and covered by the country plough 25 lbs. (one maund, local) is the rate to give a good stand. With bazaar seed which is generally of lower germinating capacity, up to two maunds (50 lb.) is necessary to give a good stand. Cambodia cotton is sown pure. At Andiyur, half a maund, equivalent to 12½ lb. is the rate per acre This gives a fairly thick stand. Thinning is not practised generally. The imperfection in covering the seeds by ploughing with country plough is accepted by the cultivators themselves. Cotton is sown mixed with coriander (*Coriandrum sativum*) about one lb. per acre. This comes to harvest in about 3½ months and helps to realise some cash which is utilised for weeding expenses and paying the land tax.

Treatment of seed.—In both villages cow-dung or buffalo-dung is mixed with the seed and rubbed well to prevent the seeds from clinging during sowing. Some cultivators mix a small quantity of red earth in addition. Buffalo-dung is generally preferred. At Andiyur some add a little powdered sweet flag (*Acorus calamus*) in this treatment, in the belief that this substance gives the seeds a certain resisting power against the attack of insect pests.

Manuring.—Cambodia cotton at Madathupalayam is manured though not directly in most cases, while dry cotton at Andiyur receives no manure. *Ragi* crop, previous to Cambodia, is manured at about 80 to 150 cartloads (about 800 lb. for each cartload) of manure which consists usually of scrapings of soil from odd corners and prickly-pear bush, tank silt, rubbish and cattle-manure the proportion of which may be estimated at about 20 per cent. Some cultivators purchase ash and charcoal powder at about four annas a cartload and apply to the fields. A few other pen their cattle and sheep in the garden during the interval after the harvest of the *ragi* crop. Thus this crop is heavily manured so that there is enough left for the succeeding cotton. The cultivator collects the manure during his leisure hours using his own animals and carts.

Irrigation.—Cambodia cotton at Madathupalayam receives irrigation from wells while at Andiyur only a few acres sown to Karunganni in gardens receive irrigation. Irrigation is effected by means of the mhote lift. Wells are deep and fairly large as they have been deepened frequently. The average depth would be about 35 feet. No well is fitted with engine and pump though in most of the wells there is sufficient supply of water for copious irrigation. During the period when cotton is growing bullocks have no other work but lifting water at the mhote. The soil being loamy and allowing free drainage, irrigation is given at intervals of a week. Between middle of December and next April as many as ten irrigations may be finished. In this tract regular and copious irrigation influences the crop very favourably for good growth and formation of bolls. The cultivator spares no pains, therefore, to keep his mhote going. He would replace a week or old animal at once, even borrowing the amount required for purchase, paying up to 24 per cent. interest. It is of interest to note in this connection that in the village of Madathupalayam one breeding-bull was maintained from 1928 to 1931 after which there have been two, one maintained by the District Board of Coimbatore and the other on premium payment basis. Since most of the cultivators possess cows, they are now taking advantage of these bulls to have a supply of improved type of working animals which play such an important part in the production of one of the best of cottons.

General conclusions on the agricultural aspect

1. Cambodia cotton is rotated with *ragi* while dry cotton is grown year after year at Andiyur. The only change is from Karunganni to Uppam and once in several years a fraction of the area may be put under Bengal gram.

2. Cambodia is sown pure but dry cotton is sown mixed with coriander.

3. Cambodia gets the benefit of the heavy dressings of manure given to the previous crop of *ragi*. Dry cotton is not manured.

4. Broadcast sowing is the method followed in both the tracts with a seed-rate of 25 lb. of seed-farm seed and 50 lb. of bazaar seed in the case of Cambodia and with about 12 to 15 lb. in the case of Karunganni.

5. North-East Monsoon rains are taken advantage of to sow the seeds and in the Madathupalayam tract to save irrigations also till about the end of November.

6. Cotton is irrigated by mhote from wells and distribution of water in the field is by the bed system, each bed measuring on the average 8 feet by 6 feet. The crop is irrigated once a week.

FINANCE

General indebtedness of cultivators.—An approximate estimate of the total indebtedness of each cultivator was made during the sowing period enquiries. The general indebtedness has been due to the following main causes:—deepening of wells, purchase of new plots at high prices, construction of bunds and weirs to prevent erosion and soil wash (in the Andiyur tract), social functions, litigation and in some cases due to standing surety to another who proved a bad debtor. The statements below show the approximate total indebtedness of the cultivators.

1. *Madathupalayam.*—Grand total debt for all the cultivators investigated —Rs. 16,650.

	No debt	Up to Rs. 100	Up to Rs. 500	Up to Rs. 1,000	Up to Rs. 3,000	Over Rs. 3,000
No. of cultivators .	2 (9)	11 (34)	16 (55)	6 (43)	3 (33)	1 (15)
Percentage . .	5·1	28·2	41	15·4	7·7	2·6

2. *Andiyur.*—Grand total debt for all the cultivators investigated— Rs. 81,000.

	No debt	Up to Rs. 100	Up to Rs. 500	Up to Rs. 1,000	Up to Rs. 3,000	Over Rs. 3,000
No. of cultivators .	18 (627)	19 (170)	21 (309)	3 (126)	12 (626)	1 (106)
Percentage . .	24·5	25·7	28·4	4	16·1	1·4

Figures in brackets give the total area of the holdings in acres.

Permanent improvements to holdings.—The total expenditure on recent permanent improvements is over 28 per cent. of the total debt of the cultivators at Madathupalayam and it is 43 per cent. at the other village. The following statement shows the expenditure under different heads.

	On wells	On buildings	On bunds	On weeding	Total
	Rs.	Rs.	Rs.	Rs.	Rs.
Madathumpalayam . .	2,910	800	1,000	..	4,710
Andiyur	9,300	..	3,775	375	13,450

Borrowings during the period of investigation.—Out of a total of 75 cultivators investigated for both villages, 39 have borrowed, or 52 per cent.

	Madathupalayam	Andiyur	Total
No. borrowed	17	22	39
Percentage	46	58	52

At Andiyur the number of borrowers is larger and the amount is also considerably greater. At the other village the amount borrowed by each cultivator does not in most cases exceed Rs. 100, while at Andiyur the amount is generally over Rs. 100 in spite of the fact that coriander and Bengal gram sown along with cotton are sold in the interval to meet cultivation expenses and land tax. Perhaps the borrowings would be more but for these subsidiary crops. At any rate this state of affairs shows to what extent the cultivators depend upon cotton in this village. The following statement gives a general idea of the borrowings.

	Madathupalayam	Andiyur
Total amount borrowed	Rs. 1,390	Rs. 4,050
No. of cultivators recorded	37	38
Borrowing per head of cultivator	Rs. 37·6	Rs. 106·5
No. of borrowers	17	22
Borrowing per head of borrowers	Rs. 82	Rs. 184
Total area of holdings recorded	220 acres	1,362 acres
Borrowing per acre of the total area of holding	Rs. 6·3	Rs. 3
Area under cotton	168 acres	979 acres
Borrowing per acre under cotton	Rs. 8·3	Rs. 4·1

It will be seen that borrowing has not been heavy. Perhaps it was far heavier a few years ago, before the period of depression.

Utilisation of the loans.—In the statement below under item 'cultivation expenses' the amount shown for both villages refers to advances made for seed-farm purposes and intended for cultivation expenses as such. Of course the cultivator is at liberty to utilise a portion for other purposes. All the other cultivators except those who obtained the amount for purchase of animals, utilised the loans for various purposes, including in one instance for funeral expenses.

Items of expenditure	Madathupalayam		Andiyur	
	Amount	Percentage	Amount	Percentage
	Rs.		Rs.	
General expenditure (includes domestic and cultivation expenses)	575	41·4	3,350	82·7
Cultivation expenses (seed-farm advances)	530	38·2	250	6·1
Purchase of animals	135	9·6	450	11·2
Repairs to mhotes, buckets and others	150	10·8	..	..

None of the loans was utilised to pay back old debts. Perhaps in a few cases interest alone was paid. The cultivators got the amount they actually signed for.

Borrowing of proprietors and tenants.—The following statement shows the amount borrowed by each class of cultivators:—

	Madathupalayam			Andiyur		
	No.	Total Amount	Amount per head	No.	Total Amount	Amount per head
		Rs.	Rs.		Rs.	Rs.
Proprietors . .	9	795	88	19	3,800	200
Tenants . .	5	320	64	..	..	..
Proprietor-Tenants	3	275	92	3	250	83

Correlation of borrowings to production.—In both villages cotton occupies about 75 per cent. of the area of the holdings and therefore the borrowings may safely be correlated to the value of outturn of cotton. In the first village the average yield is 833 lb. kapas per acre. The price of this quantity at Rs. 28 per *pothie* of 260 lb. (the average rate for 1933) will be Rs. 90. The borrowing per acre of the total area under cotton has been Rs. 8·3. The index of borrowing is 9·2 per cent. This is low enough. But it is likely that it was much higher before the present period of depression.

In the case of Andiyur the average yield per acre is 212 lb. of kapas. The value of this quantity at Rs. 26 per *pothie* of 260 lb. will be Rs. 21. Borrowing per acre of the total area under cotton has been 4·1. The index of borrowing works out at 19·5. Borrowing is therefore heavier in the dry land village than in the more intensively cultivated village of Madathupalayam.

Sources of borrowings.—The following statement shows the sources and the amount with the percentages.

	Madathupalayam			Andiyur		
	No. borrowing from each class	Amount	Percentage of the total	No. borrowing from each class	Amount	Percentage of the total
		Rs.			Rs.	
Money-lenders .	2	75	5·5	10	1,875	46·3
Friends and neighbours . .	6	265	19·1	5	375	9·2
Landlord . .	5	320	23	3	250	6·3
Trading society (seed-farm advance) . .	3	530	38	..	..	..
Agricultural Department (seed-farm advance) .	..	..	..	1	250	6·1
Co-operative society	..	..	..	1	300	7·4
From ginning factory . .	1	200	14·4	2	1,000	24·7
Total .	17	1,390	100	22	4,050	100

During the investigation it was observed that the cultivators generally borrowed with the greatest hesitation and the minimum that would possibly suffice. They resort to money-lenders after making efforts in other directions. This is shown by the large number that manage to take loans from friends and neighbours. Such loans carry low interest and for small amounts (less than Rs. 50) no interest is charged. Those who obtained loans from ginning factories got them as advances over kapas sent through merchants who took delivery of the kapas in the village itself. The settlement of the price of the kapas would be made at a future date at the option of the cultivator. The cultivators, however, expressed that even this system was not giving satisfaction to them and they resorted to this only when they required some advance and when the prices are continually on the decline.

Seed-farm advances.—The Co-operative Trading Society at Tirupur controls the 'outer' seed-farm area (the 'inner' area being under the Department of Agriculture), under Cambodia cotton. An advance of Rs. 25 per acre is made on the seed-farm area, financed by the District Urban Bank of Coimbatore. During the season under investigation though as many as eleven cultivators agreed to have seed-farm area, only three received advances and the others were not paid. They were not paid because it was said that they already owed to the Co-operative Society varying amounts and therefore became ineligible to receive advances. There is however no connection between the work of the Co-operative Society and the management of seed-farms. The amount advanced on seed-farms is recovered definitely from the sale of kapas. The regrettable sequel was that the Trading Society tended to become unpopular and there was a great reduction in the quantity of kapas delivered from the seed-farm area, as the cultivators had sold independently.

Rates of interest.—The following statement shows the rates of interest, the amount taken on each rate and the percentage:—

Rates of Interest	Madathupalayam		Andiyur	
	Amount	Percentage of the total	Amount	Percentage of the total
	Rs.		Rs.	
No interest	855	61·5	400	9·8
9 per cent.	50	3·6	400	9·8
12 per cent.	410	29·5	2,600	64·2
15 per cent.	..	..	450	11·1
18 per cent.	..	..	50	1·3
24 per cent.	75	5·4	150	3·8
Total	1,390	100	4,050	100

These two villages being centres of the seed-farm area, a large proportion of the amount is shown as having been obtained without interest. The majority of the loans, however, have been taken at 12 per cent. interest and this shows that the interest rates are not high enough. However, a few of the cultivators have obtained at over 12 per cent. from the well-known Chetti money-lenders. They resort to these Chetties when the amount is not otherwise obtainable and is urgently wanted.

Effect of borrowing on sales.—In no case the produce was pledged or given as security for the loan except under seed-farm conditions and except perhaps in the case of those who delivered to merchants connected with the ginning factories, the price to be settled at a later date. The cultivators were free to sell their produce at any time they wished.

General conclusions

1. Though only about 50 per cent. have borrowed, more would have done so if there were greater facilities for obtaining loans.

2. Most of the borrowings were in the first and second periods of investigations, *i.e.*, before the produce was sold.

3. Borrowing may be said to be moderate as the indices of borrowing are 9·2 and 19·5 for the two villages, respectively.

4. Forty-one per cent. of the amount borrowed at Madathupalayam and 70 per cent. at Andiyur were utilised for general expenditure. About 35 per cent. and 60 per cent., respectively, may be said to have been utilised for unremunerative purposes, *i.e.*, not connected with the production of the crop.

5. The borrowed amount is fairly distributed among the different classes of lenders except the Co-operative Society.

6. Very appreciable amounts have been taken without interest, but these mainly consist of seed-farm advances. Majority of the loans are at 12 per cent. and therefore interest rates are low enough. Difficulty of obtaining finance has been more keenly felt by smaller cultivators some of whom obtained loans even at 24 per cent.

SALES

Time and place of sales.—At the garden village of Madathupalayam all the kapas has been sold before the end of the third period, *i.e.*, by the 15th July, while at the dry land village of Andiyur as much as 36 per cent. remained unsold after the third period, *i.e.*, after 31st August. In August-September of 1932 there was a phenomenal rise in the prices and therefore some of the cultivators held on the stock in the hope that such a rise might occur this year also. The following statement shows the quantity sold in different periods and places.

	Madathupalayam		Andiyur	
	Quantity in lb.	Percentage to total	Quantity in lb.	Percentage to total
Second period	2,340	1·7	455	0·2
Third period	132,378	98·3	134,385	63·5
Not sold	..	..	76,960	36·3
Sold in the village	76,118	56·5	90,640	42·8
Delivered to landlord	20,580	15·3	..	..
Delivered to ginning factory	38,020	28·2	44,200	20·9

There were no market sales. It may be taken that practically the whole lot of kapas was sold in the last period, *i.e.*, about the time and after harvest was completed. The desire of the cultivator is to sell his produce in a lot when price is most favourable. It is his pious wish that the period of highest price and that of the completion of harvest should synchronise.

The smaller cultivators have all sold in the village. Some of the larger cultivators have delivered the kapas to merchants connected with ginning factories of the towns, the price of kapas to be settled at a later date favourable to the seller. This enabled the cultivator to get an advance on the kapas. However selling in the village itself is favoured by all cultivators. In the case of kapas delivered to landlord, it was done so in lieu of the loan taken by the tenant, and the landlord sells the kapas at his option and settles the account of the tenant.

Method of sale in the village.—As purchasers go to the village and take delivery of the kapas at the door of the cultivator, the latter has to make very little effort in the matter of disposal of his produce. Often the purchaser takes the help of one of the cultivators of the village who acts as the broker. This man is paid by the purchaser at 4 to 8 annas per *pothic*. The weighmen are also paid by the purchaser. When once the price is settled the cultivator has no other charges to pay or any deductions to bear. The price is settled after thorough inspection of kapas.

On *shandy* (weekly fair) days at Avanashi petty merchants visit the village or wait on the roadside under trees with the Salters spring balance tied up, and make purchases of head-loads of kapas brought by small cultivators and coolies. Such a trader is not popular as he is believed to tamper with the spring balance to his advantage.

Merchants or their agents from the nearby towns of Avanashi, Tirupur Udamalpet and Pollachi visit the villages for purchase of kapas. They have to cart the kapas at their expense. On account of want of sufficient credit due to low margin of profit and often loss, a large number of the petty merchants have ceased to function in the villages. Now-a-days the bigger merchant from the towns purchases a large quantity of kapas of all grades at different prices, gins the stuff as a lot and thus tries to make a profit. One other reason for the fall in the number of small purchasers in the village, seems to be the fact that the prices demanded in the villages are the same (sometimes more) as those current at Tirupur. Information about ruling prices at Tirupur market reaches the villages far sooner now than previously, thanks to the motor bus services.

Weights used.—Even in the matter of weight the purchaser has no option but to use the weights supplied by the cultivator. Stone weights are used generally in both villages. In addition, at Madathupalayam Salters spring balance is also used. Both these are owned by cultivators themselves. A common stone weight or spring balance may be used by several cultivators. The trader's spring balance is never trusted now. Stone weights as used at Madathupalayam, weigh 25 or 26 lb. equivalent to the local maund, that at

Andiyur weighs 22½ lb. equivalent to one *thulam*. However the consensus of opinion was in favour of standardising the weight and making it uniform in all villages, in conformity with those prevalent at Tirupur. The unit for settlement of price is the *pothie* which is equivalent to 260 lb. at Madathupalayam and 270 lb. at the other village. It is only when the ryot is selling small quantities that the rate per maund or *thulam* is taken into account—

26 lb. = 1 maund

10 maunds = 1 *pothie*

22½ lb = 1 *thulam*

12 *thulam* = 1 *pothie*

The stone weights possessed by cultivators are not accurate and often weigh less—to the advantage of the seller. However there has been no dispute on this or other account, as the defects, if any, in kapas and the deficiency in the weight are all overcome in the adjustment that is made in the price per *pothie* of kapas. The cultivator asserts however that he gets less favourable prices if his own weight, or that supplied by him, is used.

Payment.—Payments have been prompt.

Storage.—Kapas is stored in cultivators' own houses and there is no common storage place. None of the cultivators expressed any difficulty in this connection.

Rates.—All the cultivators have sold or delivered as kapas and insist on the prices being settled on kapas only. In the few cases in which kapas was delivered to merchants without settling the price, it was done so to get an advance and to wait for a further period expecting a favourable turn in the prices. The larger cultivators only go in for this method of sale.

In the beginning of the season under investigation the prices started low and gradually rose by about 30 to 40 per cent. and was steady at that level during the middle period. The cultivators therefore had a very favourable time and it was fully taken advantage of at Madathupalayam. The following are the highest and lowest rates obtained for the two varieties in the two villages: —

	Cambodia				Karunganni			
	Madathupalayam				Andiyur			
	Lowest		Highest		Lowest		Highest	
	Rs.	As.	Rs.	As.	Rs.	As.	Rs.	As.
Early period	22	8	24	0	21	8	24	0
Late period	27	0	31	0	25	0	27	8

(per *pothie* of 260 lb.)

The rates paid at the village were practically the same as were current at Tirupur at the time of sales. Information about prices current at Tirupur are made available daily in the villages through private sources and the cultivators generally do not place much reliance on the words of the trader.

Sales societies.—The Tirupur Co-operative Trading Society is located about ten miles from Madathupalyam village and a branch of this society is working at Udamalpet town about five miles from Andiyur. None of the ryots investigated deposited the kapas in the society or effected the sale through the society. Till the previous year most of the cultivators of this village had ginned and sold co-operatively since there has been every year a large area under seed-farm; this year in the absence of the usual advances from the Tirupur Co-operative Trading Society, they seem to have felt that they are sufficiently experienced and also in a position to market their produce themselves. This, however, is to be deprecated as in such a case it will not be possible to have any control over the produce to maintain a steady supply of the improved seeds to the cultivators at large during the following year. The trading society is however said to be exacting in the matter of commission on sales, interest charges on advances, rent for godown space and hire for *borahs* (gunny-bags). The bigger cultivators especially state that just as favourable or even more favourable terms can be obtained from the commission *mundies* at Tirupur.

Unsold kapas.—At the dryland village of Andiyur 36 per cent. of the stock was unsold even two months after completion of harvest. This stock belonged to nine cultivators or 24 per cent. among whom five are medium-large and large cultivators. During August and September the prices were more on the decline and hence those who were holding on would have incurred loss. At this village it is interesting to note that much of the stock of the previous year was sold during the present season. It seems to be a regular habit for some of the cultivators to keep the stock till a very late period.

General conclusions on sales

At Madathupalyam all the produce was sold but at Andiyur 36 per cent. remained unsold on the 31st August 1933.

2. Selling in the village itself is the rule. The merchant from the nearby town or his agent is the purchaser.

3. Once the price is settled no other charges or deductions are borne by the cultivator. The weighmen are paid by the purchaser. Payments are prompt.

4. The weights used are of stone generally and are available in the village. Salters spring balance is also used at Madathupalyam. This is also owned by the ryots. All the cultivators expressed that the weights should be standardised in the villages in conformity with Tirupur.

5. Kapas is stored in the houses of the cultivators. For Madathupalayam there are two ginning factories within a mile's distance, while for Andiyur the nearest factory is at Udamalpet, 5 miles away.

6. Prices are greatly fluctuating during the season and no normal rate can be worked out.

7. Cultivators make it a point as far as possible to sell in a lot. The quantity sold in the early period is negligible.

8. At Madathupalayam the desire is to sell as early as possible—as the cultivators require money for carrying on cultivation in garden and for expenses for maintaining their cattle—while at Andiyur the majority are not so keen on selling early.

Appendix

Village statistics, Madathupalayam.—Being a hamlet of Avanashi village definite statistics for this village alone is not kept in the revenue registers. Information about Avanashi village is given below—

Madathupalayam—

Population about 250
Houses about 40
Wells round about 20

Avanashi village—

Population 4,888
Total area 1,825 acres
Assessment Rs. 2,596
Number of wells—132
Area under cotton—
Irrigated 1932-33—366 acres
Unirrigated 1932-33—10 acres

Andiyur—

Population—1,200
Total area—1,785 acres
Total assessment Rs. 2,129
Total number of houses—134
Number of wells—37
Area under cotton, 1931-32—
Karunganni—827 acres
Uppam—4 acres
Cambodia—6 acres

FURTHER OBSERVATIONS ON CANE MOLASSES AS A CATTLE FEED

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An experiment on the use of cane molasses as cattle feed was conducted during the winter months of 1933, the results of which have been published by the authors [Labh Singh and Sodhi Gambhir Singh, 1934]. In this experiment it was found that two lbs. of molasses could replace two lbs. of maize grain in a mixed ration. It was also shown that molasses could be fed to bullocks at the rate of four lbs. per animal per day during winter without any ill-effect on their health, but the second two lbs. of molasses were not so efficiently utilised by the animal system and they could only replace 2·5 lbs. of mixed fodder. In order to see the effect of feeding cane molasses to bullocks in summer season another experiment was conducted on the same lines as given in the article referred to above. The number of animals under experiment was, however, twelve this time. Six of them were fed on molasses and the other six received an equivalent quantity of maize grain and served as control. The experiment lasted for over two months from 20th July 1933, to 27th September 1933, when it was discontinued because the health of the animals fed on molasses showed signs of deterioration. Their dung became watery and dark in colour. Some of them went off feed, while others, when at work, began to breathe quickly during the hotter part of the day. Thus it would be seen from these results that feeding of cane molasses in summer season to bullocks is not advisable.

To study if feeding cane molasses to bullocks during winter season successively has any ill-effect on their health, another experiment was conducted in 1934. The same twelve bullocks, which were given cane molasses* in the winter of 1933, were fed on two lbs. of molasses and two lbs. of mixed ration, consisting of gram, maize and *juar*. The control animals (twelve in number) received two lbs. of the same mixed ration plus two lbs. of maize. In this experiment no record was kept of the body weights of the animals, the object of the experiment being only to study the cumulative physiological effect of cane molasses. Both the groups kept very good health and no difference in the condition of the animals fed on molasses and those fed on maize was noticed. The experiment lasted from 6th January 1934 to 2nd April 1934.

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* Cane molasses used in this experiment were obtained from the manufacture of sugar by the open pan system. For details please see *Agriculture and Live-stock in India*, Vol. IV, Part II, pages 156 to 175.

Conclusion

No harmful effect of feeding cane molasses during two consecutive winters to the same animals has been noticed up to the beginning of July. It can, therefore, be said with confidence that feeding cane molasses to animals up to 2 lbs. per animal per day in winter is quite safe and economical. As said before feeding cane molasses in summer months, however, is not safe.

REFERENCE

Labh Singh and Sodhi Gambhir Singh (1934). *Agriculture and Live stock in India*, 4 156—175.

ERADICATION OF PRICKLY PEAR BY COCHINEAL INSECTS IN THE BOMBAY PRESIDENCY

BY

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The prickly pear or cactus is a noxious weed which has spread wild at an alarming speed in India as in all other countries where it has been introduced. The species that are found wild in India according to Burkill [1911] are:—

(1) *Opuntia monacantha*, (2) *Opuntia dillenii*, (3) *Opuntia elatior*, and (4) *Opuntia nigricans*. Out of these species *O. elatior* is the species common throughout the Bombay Presidency, with the exception of the heavy rainfall tracts of the Konkan where it is rare. This pestilential plant defies all mechanical methods of control such as cutting, digging, and burning. Chemical methods of destruction are costly and require the services of trained men. Recently, however, it has become possible to destroy cactus cheaply and effectively by the introduction of a species of cochineal insect known as *Dactylopius tomentosus*. It is intended to give in this article an account of the spread of this cochineal and of the success achieved in eradicating cactus under Bombay conditions.

HISTORICAL

The cochineal insects belong to a genus of mealy-bug formerly known as *Coccus* and now known as *Dactylopius*. The name "mealy-bug" is applied to those scale insects which are protected by a covering of fine threads of a waxy substance. The cochineal insects have been known for a very long time as a source of a red colouring matter. There are about six species that subsist on prickly pears. Though all the species of the genus yield this colour, one of them produces much more in proportion to its dry weight and that of a higher quality than the remaining species. This true cochineal was known to commerce as "grana fina" and the other wild ones as "grana silvestre".

In the 18th century, various nations endeavoured to secure cochineal insects from America and to establish the cochineal industry. In no case does the attempt appear to have been successful owing to the fact that the distinction between the true cochineal and the other wild cochineals was not understood; nor was it realised that these cochineal insects would not live indiscriminately on all kinds of prickly pear, but that each species was limited to a few species of *Opuntia* on which alone it could survive. In India, such

an attempt was made by the East India Company, but it failed. However, the wild cochineal *Dactylopius indicus* which was introduced along with the genuine cochineal, fed on *Opuntia monacantha* alone and practically killed that species of cactus. It need not be added that the true cochineal did not survive.

So far as the Bombay Presidency is concerned, a reference is found in the Dharwar Gazetteer (pages 41 and 42) about cochineal insects being successfully reared for a time on the common prickly pear. On page 42 of the Gazetteer it is stated, "In 1850, under special conditions, the cochineal insects spread so rapidly as to consume all the cactus hedges near Annigeri and Gadag. People, not knowing that it was the cochineal insect, thought that the cactus hedges were dying from some disease". The species of the cochineal mentioned therein is probably *Coccus cacti*, but the species of cactus on which this was feeding is not mentioned. A great deal of literature has been published about the introduction of prickly pears and cochineal insects into India, as can be seen from the list of references at the end of this article. The most recent reference is the paper by Beeson [1934] on the same subject, in which he has treated of the history and spread of three species of cochineal insects: (1) *Dactylopius indicus*, (2) *D. cacti*, and (3) *D. tomentosus*, and also of three species of prickly pears: (1) *Opuntia monacantha*, (2) *Opuntia dillenii*, and (3) *Opuntia nigricans*. While referring to *D. tomentosus*, he says that "this species breeds only on *O. dillenii* and it does not thrive well on *O. nigricans* and does not survive on *O. monacantha*." So far as Bombay experience goes, *D. tomentosus* feeds and breeds equally well on *O. elatior* as on *O. dillenii*.*

Introduction of *D. tomentosus* into Bombay Presidency

It was in the beginning of the year 1931 that reports were forthcoming that a certain species of cochineal insects named *D. tomentosus* was very successful in destroying prickly pear in Madras. In order to see if this cochineal was in any way useful to kill the cactus prevalent in the Bombay Presidency, this cochineal was brought into the Bombay Presidency by the M. S. M. Railway authorities, by some missionaries and by the Assistant Professor of Entomology, at the Agricultural College, Poona. It was definitely known by the last named that the species of cactus found in Bombay was *O. elatior*, while that in Madras was regarded as *O. dillenii*; but as this species of cochineal was not so strictly monophagous as *D. indicus* and was known to feed on more than one species of prickly pear, it was thought that there was every possibility of this insect feeding on *O. elatior*.

On getting the consignment of cochineal insects at Poona from the Madras Entomologist, the insects were introduced on to prickly pear bushes over the College estate. In the beginning, these insects did not thrive at all in places which were in the open and unshaded, while they became well established

*It is possible, however, that there may still be some confusion in the nomenclature of prickly pears in India.

in places which were shady and well protected from heavy rains and winds. The cochineal showed very slow progress in the beginning as it seemed to take time to acclimatise itself to its new environment. When it was once well established, it showed remarkable progress. It spread automatically all over the area and killed all the bushes that it could reach.

Nature of damage to the cactus by cochineal

Once a plant or a bush is inoculated, the first effect noticed is the withering and drying of the joints, and afterwards the whole plant crumbles. Even an ordinary onlooker wonders whether such a small number of bugs is really capable of killing the plant outright or whether these insects are injecting some kind of disease as they feed. Dodd [1927] says, "The exact nature of the effect of cochineal is a matter of conjecture. In many cases the virulent nature of the attack is out of proportion to the number of infesting insects, the feeding of which alone would not destroy the plant so readily. Either there is some striking alteration in the chemical composition of the pear or the cochineal introduces a virus or a bacterial disease that amplifies the injury." This was exactly our doubt and in order to ascertain if there was any fungus or bacterium responsible for the death of the attacked cactus, affected joints were sent to the Plant Pathologist to Government, at the Agricultural College, Poona, for examination. He has been able to isolate a fungus—a species of *Phoma*—from these dying joints. The investigation of its pathogenicity, life-history and habits is not yet complete.

Conditions suitable for the growth and spread of cochineal

The cochineal increases more rapidly in moist weather, *i.e.* when the atmosphere cools down after one or two showers of rain. Continuous rain and wet conditions retard its growth. Severe cold arrests its development and so also do very hot days. Shady places are always favourable for its luxuriant growth, at least in the initial stage of its inoculation.

Destruction of cactus is complete

The bushes once infested slowly begin to wither and gradually dry up. After a time they fall to the ground absolutely reduced to skeletons. The insects that are present on the bushes also die. The dead plants can be easily lifted out of the ground showing thereby that they have been killed root and branch. Such dead plants have been examined after the rainy season and nowhere has regrowth taken place proving that the destruction of the cactus is complete.

A remedy much appreciated by the people

The news that there has been found a very inexpensive remedy to kill the cactus by means of insects was so welcome to the public that enquiries came pouring in from all over the Presidency wherever the cactus was a nuisance. To all such inquirers cochineal insects were supplied with all instructions regarding the technique of inoculation and propagation. Except for a very few

cases, the cochineal has everywhere been successfully spreading and destroying the bushes. The failures were due to wrong ways of applying the infested joints to the healthy bushes. The joints infested with insects must be placed actually touching the joints on the healthy bushes, so that, immediately on emergence, the crawlers can easily get good positions to settle. If once the young ones fail to do this, they die in the attempt of finding out suitable spots

FALSE FEARS

There were some complaints received from the Satara and Bijapur districts that the winged insects emerging in numbers out of the infested cactus caused great nuisance to human beings by getting into the eyes and falling into edible commodities in shops. It was also greatly feared that these would attack other crops. Those who know the life-history of this insect recognise these winged insects to be the males and as such incapable of doing any harm to plants. As regards the trouble to human beings such an influx, if it occurs at all, can only be occasional. The places whence the reports had been received were visited and the people made acquainted with the life-history of the cochineal.

A mealy-bug was noticed on some crop in the Bijapur district and an alarm was raised that the cochineal was attacking other crops also. The specimens of mealy-bugs were called for and indentified and people were informed that these bugs were quite different from the cochineal and that their fears were baseless. The people were thus satisfied on this score

ENEMIES OF THE COCHINEAL

The cochineal insects in their native country are said to be attacked and kept under check by various parasites and predators, but none of these enemies nor any disease attacking the cochineal is known here.

CACTUS-KILLING BY COCHINEAL—AN ITEM FOR PROPAGANDA

The Entomologist has proved by experiments in the laboratory and in the fields that the cochineal insects successfully feed on and ultimately kill *O. elatior*. The technique of inoculation and propagation has been described and published in the *Poona Agricultural College Magazine* (No. 2, 1932), and also in the Marathi magazine *Shethi ani Shetkari*. Cactus-killing by cochineal has now been taken up as one of the items of propaganda by the agricultural overseers working in the Districts, Taluka Development Associations, Rural Uplift Centres, Local Boards and Municipalities. This method of destruction has been exhibited and demonstrated at all shows and demonstrations.

The following table shows the distribution of cochineal so far as known, in the Bombay Presidency, since 1931.

Statement showing the introduction and progress of cochineal insect on prickly pear, in the Bombay Presidency, by the Agricultural Department and other agencies from the year 1931 to 1934.

Name of the district	No. of *talukas* and *petas*	No. of villages and places	Year of introduction	Source of the cochineal	Agencies introducing it	Remarks
I.—Poona	7	19	1931, 1932 and 1933.	I.—Entomological Laboratory, Poona. II.—The Entomologist, Coimbatore.	I.—Chief Officer, Poona City Municipality. II.—Professor of Entomology, Poona. III.—Private IV.—M. S. M. Railway Authorities.	Killed. " " "
II.—Satara	1	63	1932	Not known.	I.—M. S. M. Railway Authorities. II.—Taluka Development Association. III.—District Local Board	Killed. " "
III.—Belgaum	9	174	1931	District Agricultural Overseer.	I.—Taluka Development Association. II.—Municipal Authorities III.—Agricultural Overseer, Gadag and Chikodi. IV.—Private.	Killed. " " "
IV.—Dharwar	12	26	1931, 1932 and 1933.	I.—Entomologist, Mysore. II.—Deputy Director of Agriculture, Madura, Madras. III.—Deputy Director of Agriculture, Mysore.	I.—Private. II.—District Agricultural Overseer, Gadag. III.—Taluka Development Association. IV.—District Local Board	Killed. " " "

V.—Bijapur .	6	11	1932 and 1933	I.—Railway Authorities II.—District Agricultural Overseer, Gadag	I.—Municipal Authorities II.—Railway Authorities III.—District Agricultural Overseer	Killed " "
VI.—Sholapur	2	6	1933	I.—Entomological Laboratory, Poona	I.—Agricultural Inspector, Sholapur II.—District Local Board	Killed "
VII.—Ahmednagar	4	6	1931	I.—Christian Mission, Rahuri	I.—Gram Panchayat II.—Private III.—Christian Mission, Vadala	Killed " "
VIII.—Nasik	4	110	1932 and 1933	I.—Ahmednagar Mission II.—Entomological Laboratory, Poona	I.—Private II.—Mamlatdar, Yeola	Killed "
IX.—Surat	1	1	1934	I.—Entomological Laboratory, Poona	I.—Private	
Total .	46	416				

REFERENCES

Alexander, W. B. (1925). *Commonwealth of Australia, Institute of Science and Industry, Bull. No. 29.*

Beeson, C. F. C. (1934). *The Indian Forester* **9**, 203.

Burkill. (1911). *Rec. Bot. Surv. Ind.* **4**, No. 6.

Burns, W. (1914). *Agric. Jour. Ind.* **9**, 362.

Dodd, A. P. (1927). *Commonwealth of Australia, Council for Scientific and Industrial Research. Bull.* No. 34.

Gazetteer of the Bombay Presidency. Vol. XXII, Dharwar.

Hutson, J. C. (1926). *The Trop. Agriculturist* **67**, 290.

Ramkrishna Ayyar, T. V. (1931) The Coccidae of the Prickly pear in South India and their Economic Importance. Indian Science Congress, January 1931.

Report of the Prickly pear Commission of Australia, 1914.

Tryon, H. (1910). *Queensland Agric. Jour. 1910.*

Watt, G. (1908). Economic Products of India, Vol. V.

REPORT ON THE WORKING OF PNEUMATIC RUBBER TYRE EQUIPMENT FOR FARM CARTS

I. IN THE PUNJAB

BY

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This equipment was received in September last from the Dunlop Rubber Co., for trial and report. In January last, a preliminary report on its performance was sent to the firm through the Director of Agriculture, Punjab, Lahore. The equipment had a larger axle, due to which the wheels made a different track to that of the country bullock carts. A new axle has since been received and fitted on to the cart. Now it makes a similar track.

The cart has now been used for carting miscellaneous commodities under a variety of conditions. The equipment shows its superiority over the country cart under all conditions.

In order to compare its draught with that of the country bullock cart, exhaustive comparative tests were arranged under 5 different conditions of ground. The empty carts weighed as given below:—

Country bullock cart	11·5 cwts.
Rubber tyred bullock cart	8·0 „

A load of 30 cwts. was used for the purpose of comparative tests. The average figures are given below:—

Type of ground	Mean draught		Reduction of draught due to Dunlop wheels
	Country bullock cart	Rubber tyred cart	
	Cwt.	Cwt.	Per cent.
1. Ground tilled with *desi* plough . . .	9·0	6·39	29·0
2. Cultivated land with *sohaga* run after cultivation	6·17	4·81	22·0
3. Ordinary *kachha* road	4·43	3·66	17·4
4. *Kachha* sandy road	6·0	5·67	5·5
5. *Pucca* road	3·8	3·22	15·3

It was very difficult to attach the dynamometer to the cart. The above-quoted figures are therefore only relative. Their absolute value may differ from what is given above. The above figures show that under all conditions of ground on which the carts were tested the draught of the cart with rubber tyres is less than that of the country bullock cart. In other words, it means that with the same draught, the rubber-tyred cart will always carry more load as compared to the country bullock cart.

The cart has travelled 908 miles and hauled a load of 11,293 mds. by the close of August, 1934. No trouble has so far been experienced due to the use of the Dunlop wheels. The equipment is in a good condition.

II. IN THE BOMBAY PRESIDENCY

By the Professor of Agriculture, Agricultural College, Poona.

The cart was built on two wheels fitted with Dunlop pneumatic tyres and the body was made of iron frame work with the floor of the trough lined with wooden planks. The measurements of the ordinary and rubber-tyred cart are given below:—

Kind of cart	Weight in lbs.	Weight of the axle from the ground	Dimensions of the trough: Height	Length	Breadth	Distance between the two wheels	Length of the beam
Rubber tyred cart.	810	17	7 ft. ×	1 ft. 11 in. ×	3 ft. 6 in.	5 ft.	6 ft.
Country cart .	866	24 in.	6 ft. ×	1 ft. 5 in. ×	2 ft. 7 in.	4 ft. 1 in.	6 ft. 3in.

The rubber-tyred cart was once tried loaded with 2,390 lbs. cattle ration on *murum* as well as earthen farm roads over a distance of 1½ miles. The cart was easily drawn by a pair of bullocks. It was tried again with a load of 3,000 lbs. weight over the same distance on a more rough road and in fields of the farm area. The cart ran smoothly, except for slight slipping on a descent. Turning of the cart could be easily done. It is risky to run the rubber cart with a heavy load on a steep gradient without a brake. It worked well without brake on the farm which has a gradient of about one in one hundred.

A country cart can haul from 800 to 1,000 lbs. of load. The rubber-tyred cart can therefore haul double the load. The rubber tyred cart was also tried for carting various farm articles and household kit for 3-4 days. The lesser height from the ground gives greater ease for loading and unloading and saves some time and labour. The road clearance is only 17 in. against 24 in. of an ordinary bullock cart. The trials were conducted at the Agricultural College Farm, Poona.

III. IN THE CENTRAL PROVINCES

By the Director of Agriculture, Central Provinces, Nagpur.

1. The types of cart tested were:—

(*a*) A two-wheeled cart of the usual type with steel-shod wheels

(*b*) A cart fitted with Dunlop equipment, *i.e.*, pneumatic tyres and roller bearing hubs

2. The tests were carried out on three different types of road.—

(*a*) Metalled

(*b*) Sanded farm road

(*c*) Ordinary farm road

3. Specifications

	Ordinary farm cart	Cart fitted with Dunlop equipment
(*a*) Wheel . .	Twelve wooden spokes with mild steel-tyres 2·5 in. × 19½ in.	Dunlop pneumatic tyred wheels fitted on hubs with roller bearing. Nominal size of tyres 8·00 in. × 19·00 in. Inflation pressure 40 lbs., 12 ft. long × 4 ft. wide.
(*b*) Dimensions of cart	6 ft. long × 4 ft. wide. .	..
(*c*) Weight unladen .	1,152 lbs. . . .	1,116 lbs.

Type of road	Load carriod in cart. (lbs.)	Mean draught in lbs.		Time taken for a known distance		
		Ordinary farm cart	Dunlop pneumatic tyred cart	Reduction of draught due to Dunlop wheels (per cent.)	Ordinary farm cart (minutes)	Dunlop tyred cart (minutes)
Metalled road . .	1,956*	198	143	28	..	..
Sanded farm road .	1,956*	209	154	26	25	18
Ordinary farm road .	1,956*	231	154	33	..	..
Metalled road . .	2,724*	231	143	38	..	..
Sanded farm road .	2,724*	253	154	39	35	20
Ordinary farm road .	2,724*	Too heavy to pull	176	..	..	..
Metalled road . .	3,876*	Too heavy to pull	155			
Sanded farm road .	3,876*	Do.	176			
Ordinary farm road .	3,876*	Do. .	Too heavy to pull			
Metalled road . .	4,374*	Too heavy to pull	220			
Sanded farm road .	4,374*	Do.	242			
Ordinary farm road .	4,374*	Do.	Too heavy to pull			

* Includes weight of driver and observer.

The difference of weight between the two carts is 36 lbs. which may be taken as negligible.

Observations and conclusions

1. The draught of the Dunlop-equipped cart was found under all conditions of test to be less than that of the usual type of farm cart carrying the same load on steel-tyred wheels.

2. The reduction in draught due to the use of Dunlop equipment varied from 26 per cent. to 39 per cent. according to the load carried and the type of road traversed.

3. With draught ranging between 200 and 250 lbs. the load which could be pulled in the ordinary steel-tyred cart was round about one ton. But with the same range of draughts the Dunlop-equipped cart permitted a load of nearly two tons.

4. There is a saving in time with the Dunlop equipment, consequently more out-turn of work per day.

5. A point which requires to be investigated is the relative durability of the two types of wheels.

SELECTED ARTICLES

THE INDIAN BUFFALO AS A MILCH ANIMAL SUITABLE FOR TROPICAL COUNTRIES

BY

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I. Types of milch animals at present available in tropical India

One of the most urgent problems facing the milk producers or the dairy farmers in the tropical countries of the world today is the finding of a suitable type of milch animal, which besides yielding a sufficiently high quantity of milk must possess certain characteristics to withstand the rigours of the conditions existing in tropical countries, such as immunity to bovine diseases, constitution and hardihood to withstand severe climatic conditions, ability to thrive on coarse and at times scanty fodder, etc. The breeds of cattle at present found in some of these tropical countries do possess these characteristics in varying degrees, but their inability to produce milk in sufficient quantity make them unsuitable as dairy animals from an economic point of view. Of all the tropical countries, India perhaps possesses the best breeds of milk animals, of the Zebu type, and although of recent years the breeders have concentrated their attention to the production of more milk in these breeds, the general level of the milk yield attained is not yet sufficiently high to make them quite suitable as economic milk producers. The cow in this country in the past, was looked upon as merely the mother of the work animal required for tillage operations and other kinds of draught work, whereas, the buffalo was the principal milk producing animal. The changing conditions in the mode of agriculture in the country and other economic factors demanded, however, that the cow should produce a sufficiently large quantity of milk to maintain the farmer and his family, besides producing a work animal. This gave an impetus to the improvement of the cow as a milk animal in this country through pure selective breeding and efforts were also made to create a new breed of cattle by the crossing of the European breeds with the breeds of cattle of the Zebu type found in India, which, besides yielding a high quantity of milk would also be found suitable for tropical condition. Perhaps, in no other country of the world work on the latter method has

been carried out on such a large scale and for such a long period, as in India Results of this experiment of over 30 years, on the whole, are far from encouraging, and the experience gained indicates that although the cross-bred progeny is better than its Indian dam in its milk yield, in the first one or two generations, it deteriorates in the subsequent generations and altogether loses the constitution, stamina and immunity to diseases possessed by its ancestral dam to such a marked degree, till eventually it becomes altogether unsuitable for tropical conditions. The surest way of bringing about improvement in the Indian breeds of cattle is, therefore, breeding by pure line selection, and although great strides have been made in recent years in this direction, much remains to be done to produce a really good "dairy cow" out of the Indian breeds of cattle. In the meantime the buffalo remains the premier milk producing animal of the country and is bound to remain so for a number of years yet. Due to some of the most outstanding merits which a buffalo possesses over a cow, it is admirably suited for dairy farming in the other tropical countries of the world.

2.—Indian buffalo and some of its principal characteristics. Its origin, distribution and "habitat"

The buffalo found in India belongs to the genus Bos Bubalus and is closely related to the small number of wild buffaloes still found in some of the jungles of India, especially in the swamps of Eastern and North Eastern India and in the Central India and in the Northern parts of Ceylon. Although semi-aquatic in its natural habitat, the domesticated buffalo is to be seen all over India. Some of the best breeds are to be found in Northern India, in places which far from being swampy provide the severest climatic conditions both in summer and in winter, with a limited amount of rainfall, but which produce some of the best varieties of fodders and grasses through their river resources and irrigation facilities. Due to its semi-aquatic habit, during a hot day, the buffalo is often seen submerged in tanks and river beds with only their heads and noses showing above the level of the water. In a dry area, a buffalo keeps healthy with a daily bath of a few buckets of water generally given before milking.

As to when the Indian buffalo was first domesticated and how the different and distinct breeds which are at present found in the country originated still remains an unsolved problem, but some of the outstanding qualities of the buffalo as a milch animal and its uniformity of type indicate that the domesticated buffalo has received centuries of sound breeding. The last census figures reveal that India possessed 19,709,258 head of buffaloes. No other part of the world possesses the same number nor the same quality of animals that India does. The nearest approach to it in number is in Italy where the buffalo is looked upon more as a draught than a milk animal.

Conformation and colour.—The Indian buffalo is a massive animal and although by some it is considered ugly in appearance, it provides some of the best points of a typical dairy animal. It is generally heavy bodied, short in legs compared to the Zebu cattle of India and presents a blocky appearance.

The weight of the Indian buffalo varies from 1,000 lbs. to 1,600 lbs. in females and 1,200 lbs. to 2,500 lbs. in males, according to the breed. As a rule it is jet black in colour, but some good class of animals are even brown, and animals are frequently seen with one or more legs white with a white spot on the forehead and the switch of the tail also white. The skin, which is very thick, is covered with scanty hair and presents a smooth and polished appearance. The horns which vary in size and shape in the different breeds, generally leave the crown of the head in a backward or downward direction. They are more or less flattened and marked with distinct rings indicative of the age of the animal. Unlike the Zebu cattle, the Indian buffalo has no hump and the neck, both in males and females, is short and thick, with the head set at the same level with the back and at a peculiar angle indicating the water dwelling habit of the buffalo. The mammary system is exceptionally well developed, with a well-shaped, proportionate udder and the teats well placed and of convenient size. Compared to the breeds of Zebu cattle there is more uniformity of type in the buffalo as a class and more fixed characteristics for the various breeds, which indicate the close attention of centuries of breeding which the Indian buffalo has received.

Breeding qualities.—Compared to the breeds of Zebu cattle it is a late maturing animal but a regular breeder and breeds for a longer time. On an average it gives the first calf at the age of 4 years, its period of gestation is of 10½ months and its period of lactation extends up to 10 months.

Milk qualities.—On the whole the Indian buffalo is a highly domesticated animal, placid, quiet and docile and this is one of the main reasons why it does so well as a dairy animal in any part of the country. The general standard of the milk yielding ability of the buffalo is higher than that of the Indian cow and the average type of good animal purchased from the open market can be depended on to yield from 3,500 lbs. to about 4,500 lbs. of milk per lactation period, while exceptionally, good animals are known to have yielded as much as 11,000 lbs. of milk within a year. As to the richness of the quality of its milk no other domesticated milk yielding animal in the world can approach it and it can truly be called a "butter producing machine." The average fat percentage in buffalo's milk varies between 7·7 to 8·3 and there are cases on record where the animals have touched even 13 per cent. while cases of 9·5 to 10 per cent. of fat are quite common. Recent systematic investigation has confirmed the belief that the Indian buffalo can thrive well on a coarser class of roughage or fodder than the Indian cow, and its capacity to convert the coarse feeding stuffs into milk is probably unequalled by any other class of domesticated animals in the world. This in itself makes it the most economical milk and butter producing animal for other tropical countries. Its milk differs in its composition and even in the chemical nature of its constituents from that of the cow. Some of the products manufactured from it obtain a better flavour and taste and consequently have better market value. For example "ghee", clarified fat, the only commercial form in which butter fat can be preserved for use for any length of time under the tropical conditions, manufactured from buffalo's

milk fetches better price in the market than "ghee" from cow's milk, because of its superior flavour and higher nutritive value. Another good point in the buffalo as a dairy animal is that the animal can be weaned of its calf without much difficulty and the calf then pail-reared.

Adaptability.—This quality varies in degree in the different breeds of buffaloes, but taken as a whole the Indian buffalo can adapt itself to varying conditions to a remarkable degree. This is one of the main reasons why it does so well as a milker in any part of India, Burma, Ceylon and the far East, where it has been imported, under conditions vastly different from those prevailing in their natural habitat.

Immunity to diseases.—The Indian buffalo posesses as great a resistance to diseases as the Zebu type of cattle and it is less susceptible than other cattle to some of the more deadly forms of contagious diseases like rinderpest, anthrax and foot-and-mouth. The calves and young stock are, however, susceptible to outbreaks of hæmorrhagic septicæmia.

Work quality.—Generally speaking the Indian buffalo male does not make an efficient work animal either for the plough or for other draught work. Although perhaps possessing greater tractive force than the bullocks of most of the breeds of cattle, due to its massive and compact body, it is too slow in its movements and it cannot stand the fierce heat of the plains. Due to its semi-aquatic habits, however, it is suitable for regions of heavy rain-fall and more particularly for rice districts, where much of the cultivation is carried on while the land is still under water. In such places, the bullock is generally substituted by a male buffalo for work.

General utility points.—Of the other important utility points may be mentioned the large carcass that the animal yields for beef, the excellent quality hide yielded by it and the large amount of fat which is obtained from this animal on its slaughter. While the above points are seldom taken into consideration by the breeders in India, they may appeal to breeders in other tropical countries of the world in determining the economic value of the Indian buffalo. The buffalo when not in milk can be fattened very easily and it is capable of accumulating large masses of fat on its body. The meat of the animal is rather coarse and fibrous in quality. There is only a limited demand for it in fresh condition in this country, but in places where buffaloes are slaughtered in large numbers, specially for fat and hide, the flesh is generally salted and dried in long strips and then exported to places like Burma, the far East and some parts of Africa where it is sold as "bultang".

3.—Breeds of Indian buffaloes

India possesses over a dozen breeds of buffaloes of both major and minor importance. Below are given five of the most important breeds found. As full description of each breed cannot be dealt with within the scope of this article, short-notes as to their location and outstanding characteristics are given.

Jaffrabari (*Plate II*).—This breed is found in the hilly parts of the forest of Girnar, in the southern portion of the Kathiawar States, situated in the western part of India. It is the biggest amongst the buffalo breeds, the females and males weighing as much as 2,500 lbs. and 3,000 lbs. respectively in exceptional cases. Both the males and the females are coarse and angular in appearance. The frontal horns are very prominent. The horns grow flat and downwards sometimes completely covering the eyes and blinding the animal. It is this peculiar formation of the head which mainly separates the Jaffrabadi buffalo from other buffalo breeds. Some of the females are exceptionally good milkers but on the whole they are late maturing and are rather irregular in breeding. Their milk is perhaps the richest obtainable in all the breeds of cattle in India.

Murrah (*Plate III*).—Its original home is along the Indus valley confined mostly to the South Western part of the Punjab and Western parts of Sind. On the whole it is the best amongst the breeds of buffaloes in India and provides the best type of milk animal available in the country. As such, it has spread in every part of India. It is a medium heavy class of animal with a square type of body frame. Its horns are its distinguishing feature, they are short, thick and much curled. The females are comparatively early maturing and are good milk yielders and regular breeders.

Mehsana (*Plate IV*).—Found in the northern portion of the Bombay Presidency towards the western part of India. A medium sized shapely breed, with excellent dariy qualities. The udder is spacious and very shapely. The head is flat, face narrow, with the horns thin and of a fair size and inclined backwards and upwards, taking a semi-circle in the middle.

Surti (*Plate V*).—This breed is similar to the above but is found in the central parts of the Bombay Presidency towards the Western Coast. It is a little lighter than the Mehsana possessing the same excellent dairy qualities. It is the earliest maturing breed in the buffaloes and is persistent in its milk yield and is a very economical milk producer.

Nagpuri (*Plate VI*).—It is found in the central parts of India and is confined to a limited area. It is perhaps the lightest amongst the important breeds of buffaloes. It is marked out for its symmetry of form, its long horns which are more or less straight and run backwards. The forehead and the four legs up to the knees are always white and animals of this breed are generally wall-eyed. They combine the milk and draught qualities in a better proportion than any other buffalo breed. As a milk producer it is fairly good.

Some of the above important breeds have been exported in large numbers to places like Burma, Ceylon and the far Eastern countries for the purposes of milk production, but their introduction in other tropical countries of the world is still very limited, perhaps because of the lack of knowledge regarding their milk producing qualities.

THE PERSISTENCY OF LACTATION AS AFFECTED BY THE FREQUENCY OF MILKING.

BY

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AND

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INTRODUCTION

It has been a matter of common observation by dairymen that the frequency of milking affects the milk yield of the cow, within certain limits. Experiments by Woodward (1) have shown that this aspect of the management of the dairy cow is of great economic significance. Encouraged by the experimental results reported by Woodward, the Allahabad Agricultural Institute Dairy adopted the practice of three time milking during a period of increased demand for milk by its patrons in the city of Allahabad. The immediate results of this change in the system of dairy management were so encouraging that the practice was continued for an approximate period of five months, during which period the increased demand for milk continued.

DISCUSSION OF THE PROBLEM

It was in studying the records that it was observed that the effects of three time milking were not uniform and that on some cows that practice acted adversely. Woodward (1) in offering an explanation of the increased milk production due to the increase in the frequency of milking says: "As the udder fills with milk the pressure exerted by the milk tends to check milk secretion and the greater the pressure the more completely is secretion checked. These facts provide a reasonable explanation of the fact that the cows yielded greater quantities of milk when they were milked oftener than twice a day". This explanation does not, however, explain the adverse effect of the increase in the frequency of milking. Woodward says further that the increase in the frequency of milking increases the persistency of the lactation of the cows. Gaines (2) supports this view that frequency of milking may be a factor in persistency of milking. Gaines in studying persistency as a hereditable character did not find any high correlation between inheritance and persistency in Holstein and Guernsey cows and says "it may be possible that there is very little variability of a genetic nature among our present dairy breeds with respect to persistency of lactation".

It may be argued, therefore, that in animals which are homozygous for dairy qualities that increased frequency of milking would act as a stimulus for increased milk production, which is the combined result of both the enhanced temporary yield and lowered rate of decrease. On the other hand, in the case of animals which are heterozygous for "dairy qualities" the increased frequency of milking might completely break down the persistency of lactation, thereby resulting in a very much lowered milk

yield. Without entering into the theories of milk secretion, it will be admitted that milk production is largely dependent upon the nervous mechanism or temperament of the cow, and that increased frequency of milking may affect the nervous mechanism of the cow in an adverse manner with regard to milk production.

If the milk production is dependent on the nervous mechanism of a cow then the question arises as to whether the frequency of milking in any way affects this mechanism either temporarily or permanently. Another question which arises is whether the increased frequency of milking which in some cases acts as an added stimulus, also affects the rate of milk secretion in any way. It is a known fact that following the peak or flush of milk production in the lactation of a dairy cow, there is decline in the secretion of milk, which ultimately ends in the drying up of the cow. The degree of this decline determines whether the cow is a more or less persistent milker. This presistency of milk yield is one of the factors measuring the efficiency of a cow as a milk producer. It follows that the smaller the rate of decline of milk yield the greater will be the milk production in a given time and the greater the rate of decline of milk yield in a given time, the smaller will be the total milk yield. It would seem, therefore, that the persistency of lactation of a cow is of very great economic importance and is a measure of the dairy qualities of cows. With a view to throwing some light on these phases of the problem confronting the authors, some of the milk records of the Allahabad Agricultural Institute Dairy were treated mathematically. The records so treated are those of animals kept under commercial and not strictly controlled experimental conditions.

THE MATHEMATICAL TREATMENT OF THE DATA

The persistency of milk yield has been expressed in various forms by different investigators. Sturtevant (3) expressed it as the decrease in milk yield from month to month, in percentage of the yield of the previous month. Turner (4) uses the method of dividing the yield for each calendar month by that of the preceding calendar month and using the arithmetic average of the ratios thus secured as a measure of the persistency. Brody *et al.* (5) have suggested that the decline in milk yield which occurs with advance in lactation, conforms to the law of mono-molecular reaction expressed in the form of an exponential equation, where the velocity constant K, measures the rate of decline in milk yield. Gaines (2) states that the milk yield is the result of the rate of milk secretion and this rate of milk secretion is continually decreasing with advance in lactation, and that the same can be expressed in the form of a differential equation:

$$\frac{dY}{dt} = Ae^{-Kt}$$

in which Y=yield in pounds; t=time of a given unit from calving; $\frac{dY}{dt}$ is the rate of yield in pounds per time unit; e (=2·71828) is the base of natural logarithms; A is the theoretical initial rate of yield and K is the rate of change per time unit in the rate of yield. K as a positive value expresses the measure of decrease. K can thus be taken as the measure of persistency.

TABLE

Daily average milk yield in 14

Name and No. of cows	Breed	0·5 1·5	2·5	3·5	4·5	5·5	6·5	7·5	8·5	9·5
							Time units of 14 day			
							Average daily milk			
Group A										
Mehendi 92 .	Scindi—Holstein .	27·30	28·80	27·45	23·60	19·30	21·36	20·97	..	25·97
Fanny 90 .	Scindi—Holstein .	28·29	30·18	28·29	25·07	24·03	23·60	24·14	22·39	27·43
Chandan 80 .	Scindi—Jersey .	20·07	19·50	17·25	15·28	16·42	16·14	..	19·43	18·96
Ladybird 40 .	Hariana . .	19·92	20·96	20·60	19·60	17·86	19·18	18·03	..	19·39
Derri 147 .	Kankrej . .	16·75	17·68	16·32	15·00	15·14	14·35	..	13·60	13·25
Group B										
Janeara 88 .	Scindi—Holstein .	19·43	19·50	19·14	18·14	21·07	21·03	18·39	19·57	18·96
Kunjan 130 .	Scindi . . .	16·43	16 03	15·50	14·19	..	16·25	15·85	14·00	12·68
Group C										
Fancy Mabel 49	Scindi . .	17·86	15·60	15·71	4·03	13·68	12·93	12·96	9·46	7·96
Ripeni 15 .	Hariana . .	25·86	26·89	24·71	22·68	20·64	15·00	8·32	3·68	..
Group D										
Jessoe 81 .	Scindi-Jersey .	34·32	34·57	33·93	30·82	28·25	27·86	24·70	20·86	20·80
Group E										
Phirpo Violet 77.	Bruno-Alpino .	27·01	29·40	26·75	26·14	23·14	21·14	22·32	23·10	23·28
Pali 106 .	Scindi—Holstein .	26·00	26·25	24·75	24·64	22·50	23·25	22·35	22·53	20·14
Felicia 93 .	Scindi—Holstein .	28·10	32·21	32·60	30·79	30·89	28·96	29·07	26·53	27·28

I.

day unit periods from calving.

period from calving reckoned to the mid point													
10·5	11·5	12·5	13·5	14·5	15·5	16·5	17·5	18·5	19·5	20·5	21·5	22·5	23·5
yield in pounds (raw milk)													
26·86	25·71	24·60	24·90	24·14	28·18	22·86	21·71	..	..	..	..	..	..
28·79	27·82	25·71	24·78	28·89	28·00	22·89	21·68	20·10	22·28	...	..	..	..
18·78	17·39	16·50	14·90	16·85	..	..	..	..	..	..	..	..	..
18·60	17·28	17·32	16·57	17·93	19·07	17·86	..	..	..	..	..	..	..
13·78	11·64	11·05	11·71	..	..	..	..	..	..	..	..	..	..
17·64	18·57	18·00	17·68	..	..	..	..	..	..	..	..	..	..
11·82	10·75	11·71	11·08	10·10	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..
20·68	17·69	16·82	16·21	16·14	16·82	..	19·57	17·71	16·89	16·25	15·68	16·57	15·75
20·50	23·32	20·85	19·61	18·10	14·35	14·00	14·82	18·18	14·10	13·60	13·25	11·39	..
20·32	18·71	16·93	17·40	16·46	16·78	16·50	15·00	..	..	..	..	..	..
28·86	26·60	25·18	23·21	22·00	[illegible]·96	18·89	17·93	17·62	16·50	15·[illegible]	14·21	..	..

The authors have followed this latter method of analyzing the data given by Gaines (2) and Gaines and Davidson (6). The equation derived from the above noted and used for application to the data is:

$$Yd = Ae^{-Kt}$$

TABLE II.

Equations from the observed yields.

	Equation for three times milking	Equation for two times milking
Group A—		
Cow No. 92 .	$Yd=35\cdot12e^{-\cdot08368t}$	$Yd=33\cdot88e^{-\cdot02455t}$
,, ,, 90 .	$Y_{\cdot\cdot}=30\cdot4e^{-\cdot03763t}$	$Yd=3\cdot39e^{-\cdot02174t}$
,, ,, 80 .	$Yd=20\cdot74e^{-\cdot04752t}$	$Yd=2\cdot442e^{-\cdot02593t}$
,, ,, 40 .	$Yd=21\cdot57e^{-\cdot02336t}$	$Yd=20\cdot04e^{-\cdot008646t}$
,, ,, 147 .	$Yd=18\cdot70e^{-\cdot04164t}$	$Yd=19\cdot45e^{-\cdot03997t}$
Group B—		
Cow No. 88 .	$Yd=20\cdot48e^{-\cdot02441'}$	$Yd=22\cdot13e^{-\cdot01635t}$
,, ,, 15 .	$Yd=17\cdot69e^{-\cdot0614t}$	$Yd=23\cdot06e^{-\cdot05853t}$
Group C—		
Cow No. 49 .	$Yd=18\cdot85e^{-\cdot05997t}$	$Yd=47\cdot64e^{-\cdot1879t}$
,, ,, 15 .	$Yd=29\cdot91e^{-\cdot04853t}$	K=5869
Group D—		
Cow No. 81 .	$Yd=43\cdot27e^{-\cdot07413t}$	$Yd=58\cdot80e^{-\cdot06092t}$
Group E—		
Cow No. 77 .	$Yd=31\cdot47e^{-\cdot0437t}$	$Yd=28\cdot77e^{-\cdot02576t}$
,, ,, 93 .	$Yd=45\cdot15e^{-\cdot05[illegible]t}$	$Yd=33\cdot06e^{-\cdot0[illegible]172t}$
,, ,, 106 .	$Yd=28\cdot51e^{-\cdot03615t}$	$Yd=27\cdot15e^{-\cdot[illegible]t}$

Ya is the daily yield for a given time unit (14 day periods) in pounds of raw milk per day: Time T, is reckoned to the middle of the period. A and K have the same meaning as above stated. The above equation may be converted to a linear form by taking logarithms on both sides, thus:

$$\text{Log}_{10}\, Yd = \text{Log}_{10}\, A\text{-}KT\ \text{Log}_{10e}$$

TABLE III.

Comparisons of K (multiplied by 10^3).

	$K \times 10^3$ Measure of persistency for two times milking	$K \times 10^3$ Measure of persistency for three times milking	Percentage decrease in the value of $K \times 10^3$ due to three times milking	Percentage increase in in the value of $K \times 10^3$ due to three times milking
Group A—				
92	83·68	24·55	70·66	..
90	37·63	21·74	42·24	..
80	47·52	35·93	24·39	..
40	23·36	8·646	62·96	..
147	41·64	39·97	4·00	..
Group B—				
88	24·41	16·35	33·02	..
130	61·40	58·53	4·67	..
Group C—				
49	59·47	187·9	..	21·59
15	48·54	586·9	..	1109·0
Group D—				
81	74·13	60·92	17·83	..
Group E—				
77	43·17	26·76	36·25	..
106	36·15	25·24	30·10	..
93	52·56	21·78	60·00	..

TABLE IV.

Theoretical yields of milk in one year from equations.

	Theoretical yield in one year (364 days) calculated to the equation of two times milking	Theoretical yield (364 days calculated to the equation of three times milking	Per cent. increase due to three times milking	Per cent. decrease due to three times milking	Per cent. decrease due to two times milking
	lbs.	lbs.			
Group A—					
92	5,208	9,116	75·0	..	..
90	7,058	9,426	33·5	..	..
80	4,376	6,248	42·5	..	..
40	5,882	6,531	11·0	..	..
147	4,158	4,402	5·8	..	..
Group B—					
88	5,520	6,073	10·0	..	
130	3,217	4,311	34·0	..	..
Group C—					
49	3,492	656	81·0	..	..
15	..	..	..	..	..
Group D—					
81	6,982	10,740	53·0	..	..
Group E—					
77	6,292	7,546	16·5	..	..
106	6,410	7,247	11·5	..	..
93	6,580	9,189	28·0	..	..

The grouping of the animals

Group A.—This group consists of those cows which were continued on two time milking for a period of 3½ to 4 months after calving. They were then placed on 3 time milking. The group consists of five cows, namely numbers 90, 92, 80, 40 and 147. Numbers 90 and 92 are half-bred Holstein-Scindi cows; number 80 is a half-bred Jersey-Scindi; number 40 is a Hariana cow and number 147 is a Kankrej cow.

Group B.—This group consists of two cows which were started on 2 times milking and continued on the same for period of 2½ to 3 months from calving and then placed on three time milking. Number 88 is a half-bred Holstein-Scindi cow and number 130 is a Scindi cow.

Group C.—This group consists of two cows, number 15, a Hariana cow and number 49, a Scindi cow. They were started on two time milking as in group B. and then placed on three time milking.

Group D.—Consists of cow number 81, a half-bred Jersey-Scindi animal This cow was started on two time milking and continued on the same for about 8 months, after which the cow was placed on 3 time milking.

Group E.—This group consists of three cows. Numbers 93 and 106 are half-bred Holstein-Scindi cows and number 77 is a half-bred Brown Swiss-Scindi cow. This group started on three time milking from calving for a period of about 12 fortnightly periods when they were placed on two time milking.

Presentation of data

The data is presented in four tables.

Table I gives the average daily raw milk production in pounds in 14 days time units for the period covering two time milking as well as three time milking.

The values of the constants *A* and *K* have been derived separately for both the two and three time milking periods, by actual calculation, using the equation referred to above and the method of least squares in evolving the same. The graphic method was not used as it was felt that the method would lack mathematical precision.

Table II gives the equations thus derived from the observed yields for the cows of all groups, A to E, for both two and three time milking. From the equations evolved it appears that the value of *K* becomes much smaller in groups A, B and D, when the animals were transferred from two time milking to three time milking. That is, the rate of decline decreased. In group C the value of *K* of both the cows becomes abnormally large, or in other words they fall off more rapidly in their milk yield. In group E, in which the animals were brought from three time milking to two time milking, the value of *K* increases.

Table III: The value of K, being very small, has been magnified by multiplying it by 10^3. The percentage decrease in the value of $K \times 10^3$ in the groups A, B, D and E ranges from 4.00 to 70·00 per cent., with an average 35·1 per cent. This means that the persistency of the cows, due to three time milking, in these groups has been increased by 35·1 per cent. In group C three time milking has resulted in increasing the value of K in one case by about 216 per cent. and in the other case by 1109 per cent. This lowering of the persistency practically dried up the animal.

Table IV gives the calculated yields for one year (364 days) from the equations of two time and three time milkings. The same formula

$$\frac{dY}{dt} = Ae^{-Kt}$$

has been used. The formula as fitted to the 14 day time units is

$$\frac{dY}{dt} = 14\,Ae^{-Kt} \quad \text{or } dY = 14\,Ae^{-Kt}\,dt.$$

Integrating both sides between the limit, $T=0$ and $T=26$, we get the total theoretical milk yield per year (364 days $= 26 \times 14$). The equation is therefore

$$Y = \frac{14\,A}{K}\left(1 - \frac{1}{e^{26K}}\right)$$

This formula was used in calculating the theoretical milk yield for the year (364 days), according to the equations for two and three time milking.

The increase in the total yield in the groups A, B, and D, due to three time milking ranges from 5·8 to 75 per cent. The average increase is about 33·1 per cent. In group C, three time milking has resulted in a decrease in the yield; in one case the decrease is 81 per cent. and in the other case three time milking practically dried up the animal. In group E, in which the cows were changed from three time to two time milking the decrease has been about 18·6 per cent., due to the reduction in the frequency of milking. The total yield of this group for two time milking has been calculated to the initial rate of the starting period.

Discussion of the observations

From the data it is observed that in those cows in whom the persistency of lactation is definitely present as a character the increase in frequency of milking helps in increasing this persistency. The values of K as given in Table III are in a strict sense not directly comparable on account of their being in two different initial rates. For direct comparison they should be corrected to the mean

initial rate. As Gaines (2) points out the mean of the K's is not the arithmetical mean but a value much lower. Accordingly the values of K, when corrected to the initial rates, would appear much smaller than are actually shown, when there is an increase in the frequency of milking. Also the values of K, when changed from three to two time milking would not appear as large as they are shown. This effect is well brought out when the total yield for one year is calculated. The increase due to three time milking is about 35·0 per cent., but the decrease due to the change from three times to two times is about 18.6 per cent. The question arises as to whether the frequency of milking in any way builds up the character of persistency and whether its effect is carried over and if so, how far? This is a question of great importance to the economic production of milk.

From the observations made on the data, the authors are of the opinion that persistency can be regarded as a character and a definite gauge of the dairy qualities of a cow. Whenever the dairy qualities of a cow are not fixed, it would be expected that any environmental change would break down the apparent persistency of the cow. In India where the dairy breeds are far more variable for their dairy qualities than the established Western dairy breeds, the study of the presistency of lactation of Indian breeds of cows as affected by frequency of milking offers a means of determining the homozygous or heterozygous nature of dairy cows or milk production. Cognizance of this character of "persistency" of lactation in the selection of animals for the improvement of dairy cattle in India would be highly desirable.

REFERENCES

(1) Woodward, T. E.: The production of dairy cows as affected by frequency and regularity of milking. *U. S. D. A. Circular N. 184*, 1931.

(2) Gaines, W. L.: Presistency of lactation in dairy cows. *Illinois Agricultural Experiment Station Bulletin* No. *288* of 1927.

(3) Sturtevant, E. L.: Influence of distance from calving on milk yield. *N. Y. (Geneva) Agricultural Experiment Station*, 21-23, 1886.

(4) Turner, C. W.: A quantitative form of expressing persistency of milk or fat secretion. *Journal of Dairy Science*, 9, 203-214, 1926.

(5) Brody, S., Ragadale, A. E. and Turner, C. W.: The rate of milk secretion with the advance of the period of lactation. *Journal Gen. Physiol.* 5, 441-444. 1923.

(6) Gaines, W. L. and Davidson, F. A.: Rate of milk secretion as affected by advance in lactation and gestation. *Illinois Agricultural Experiment Station Bulletin* No. *272*, 1926.

ABSTRACTS

Agricultural meteorology : Preliminary studies on soil-moisture in relation to moisture in the surface layers of the atmosphere during the clear season at Poona. L. A. RAMDAS, AND M. S. KATTI, (*Ind. J. Agric. Sci.* **4**, 923.)

Detailed observations of the pressure of water vapour and the degree of saturation were made at Poona in the air layers near the ground during the last winter at different hours of the day. These data reveal certain fundamental relations between the moisture in the topmost layer of the soil and that in the air layers above it. During winter and spring, when the climate of the Bombay-Deccan is of the continental type (*i.e.*, with large diurnal variation of air temperature, cloudless skies and feeble air movement) it is observed that the vapour pressure is maximum by day and minimum at night near the ground. The decrease of vapour pressure with height by day and the reverse effect at night are associated with evaporation from and absorption by the soil respectively. This has been confirmed by measurembents of the moisture content of surface soil at sunset and sunrise. (*Authors' abstract*)

Petalody in cotton. V. RAMANATHA AYYAR and R. SANKARAN (*Ind. J. Agric. Sci.* **4**, 938.)

In the course of floral observations at the Cotton Breeding Station, Coimbatore, two types of petalody were observed. In one case, the lower three-fourths of the staminal column was transformed into petaloid structures while at the summit a few fertile anthers were present. The stigmatic lobes were disherent. Attempts at securing a cross between the petaloid plant as the female parent and a normal plant as the male proved futile. But when the pollen grains from petaloid flowers were dusted on to stigma of normal flowers a few bolls resulted. The petaloid character was recessive in F_1 and segregated in a monohybrid Mendelian ratio in F_2 and F_3 indicating thereby that petalody is caused by single genic difference which is denoted by $\mathbf{Fp^d}$ and $\mathbf{fp^d}$.

In the second case the degree of petalody was weak and the anthers entirely contabescent. Though the stigma was normal, no bolls developed even with artificial pollination. (*Author's abstract.*)

Diseases of *Eleusine coracana* Gaertn. and *E. aegyptiaca* Desf. caused by species of Helminthosporium. M. MITRA and P. R. MEHTA. (*Ind. J. Agric. Sci.* **4**, 943.)

H. nodulosum B. et C. is widely distributed in India and causes a serious disease of *E. coracana.* The fungus was also isolated from *E. aegyptiaca.* Besides, a strain of *H. leucostylum* Drechs. was found to attack *E. caracana* but does much less damage than *H. nodulosum.* Both *H. nodulasum* and *H. leucostylum* cause leaf spots, seedling blight and head blight. *H. nodulosum* also causes foot-rot,

seed blight and root-rot. Inoculation experiments show that all the parts of *E. coracana* are susceptible to the attack of *H. nodulosum* and *H. leucostylum*. Seedlings are more susceptible to the attack of *H. nodulosum*. The optimum temperature for the infection of aerial parts by *H. nodulosum* was found to be 30°—32°C. with a range of 10°—37·5°C. Infection takes place through the stomata, the epidermal cells, or more frequently through certain epidermal out-growths. Both species have a wide host range as shown by cross-innoculation experiments.

Macroscopic growth features of *H. nodulosum* and *H. leucostylum* such as aerial mycelium, colour, zonation are affected by various environmental factors such as light and darkness, temperature, humidity of air and media, inhibitory influences. Microscopic growth features of *H. nodulosum* such as sporulation, shape, size and septation of conidia, shape and size of conidiophores, formation of chlamydospores and secondary spores are affected by environmental conditions. The optimum temperature for the linear rate of growth of *H. nodulosum* and *H. leucostylum* varies with the nature of the medium. *H. leucostydum* is comparatively a slow growing fungus. The linear rate of growth of *H. nodulosum* depends on a number of other factors such as the amount of medium and humidity. (*Authors' abstract.*)

Breeding for milk production in the tropics. J. Edwards (*Journal of Dairy Research, Vol. III, No. 2, May 1932.*)

One of the most fundamental problems of tropical dairying consists in the establishment of breeds of dairy cattle which will live and thrive in their environment. How this problem is dealt with in Jamaica is shown by the author by an analysis of the data of milk records and pedigrees of the dairy herd at the Government Stock Farm at Hope, Kingston, Jamaica. At this farm numerous crossing experiments have been tried with native cattle and imported European and Indian breeds, and the paper deals with the analysis of the detailed records kept of these experiments.

The analysis is divided into two parts: (*a*) the analysis of the bull's progeny (*b*) analysis of yield on percentage of Indian blood basis. An analysis of the 'failures' has also been made. And the conclusions are summarised as follow:—

1. "The European group (with no Zebu blood) is seen to possess a low average yield and a high percentage of constitutional failures. Its representatives have the inheritance to produce milk but lack the constitution to express their inheritance. The group of grades with one-half Zebu blood has a similar average yield and an equally high percentage of non-producers which might be in this case termed temperamental failure. The group possesses constitution but lacks the factors for a better milk inheritance and docility.

2. The occurrence of the highest average yields amongst the grades possessing one-thirty-second to one-quarter Zebu blood coupled with a lower percentage of failures in these grades, points to their being the most satisfactory medium for the development of a new breed suited to environment."

The author prefaces his analysis with a review of the results of cross-breeding experiments in other tropical and sub-tropical regions of the world, including India, and the review makes interesting and valuable reading. The common

feature of the experiments is that the importation of European breeds into the tropics is usually a failure and not satisfactory as a general breeding policy. The first generation from imported animals may be satisfactory but subsequent generations are usually unable to maintain the constitution necessary to thrive satisfactorily in a tropical environment.

He, therefore, draws the conclusion that for tropical countries like India the solution of the problem of providing satisfactory milch cattle for ordinary conditions of feeding and management lies in the improvement of indigenous stock. It is true that the indigenous cattle of India are usually of heterogenous origin and their improvement is likely to be somewhat protracted but the building up of a strain of improved stock always takes time; *e.g.*, the European breeds have taken two centuries to attain their present level of production.

Indian cows however possess the constitution to thrive in their environment, and experience in Texas, Kenya, Trinidad and North Africa tends to show that it is essential that a certain proportion of Zebu blood should be maintained if disease resistance and milking propensities are to be combined in one animal in a tropical environment (K. P. R. K.).

NOTES

PUSA 114 WHEAT IN SIND

AGRICULTURAL LEAFLET NO. 38 (1ST EDITION, SEPTEMBER 1934), ISSUED BY THE CHIEF AGRICULTURAL OFFICER IN SIND

Pusa 114 wheat is an improved variety of wheat which was originally evolved at the Imperial Institute of Agricultural Research, Pusa (Bihar). During the past four years, the Agricultural Department in Sind has carried out extensive trials of this improved variety, both on Government farms and on zamindari lands, in all the wheat-growing tracts of Sind As a result of these trials, the Department strongly recommends this variety to wheat-growers in the Barrage areas, especially in Middle and Lower Sind Pusa 114 wheat has been tested in comparison with Punjab 8-A in the Thar Parkar district and has been found to yield as heavily and, in addition, the improved Pusa variety is highly resistant to "rust" disease which caused much loss to growers of Punjab 8-A last season.

During the rabi season of 1933-34, Pusa 114 was grown on a large scale by several prominent zamindars in Thar Parkar and Hyderabad districts, who also cultivated the variety Punjab 8-A. In most cases, the Punjab 8-A crop was severely damaged by "rust" disease and local wheats almost entirely destroyed, while the Pusa-114 crop escaped any serious damage due to its disease-resistant character.

The main advantages of the improved wheat variety Pusa 114 are:—

(1) *It is a high yielder* —At Sakrand, it has given yields of 28 maunds of grain per acre, and in 1932 33, Pusa 114 stood highest in yielding capacity in scientific tests carried out by the Agricultural Department at the Sakrand station In the districts, especially in Middle and Lower Sind, Pusa 114 wheat has been shown to yield as well as the improved Punjab 8-A variety and gives out-turns of grain 15—20 per cent. greater than the ordinary local varieties.

(2) *It is early maturing.*—Pusa 114 wheat will ripen about a week sooner than ordinary local wheats and a fortnight sooner than Punjab 8-A. This character is most important and valuable in areas where it is essential for zamindars to sow American cotton early in the *kharif* season.

(3) On account of its early maturity, *Pusa 114 wheat can stand late sowing* and hence it is particularly suited to lands where early sowing of the wheat crop is not possible.

(4) *It is highly resistant to "rust" disease* which so frequently causes much damage to wheat crops in Lower Sind. To grow the Pusa 114 variety is to be insured against loss from "rust" attack.

(5) *It possesses a very superior quality of grain* which is high in protein content and in yield of flour. At the same time, it is suited for local consumption, *e.g.*, as *chupatties*. Pusa 114 wheat is thus well suited both for local markets and for export, and should command a higher price than ordinary local Sind wheats. In Karachi market, Pusa 114 will be classed as "sharbati" and will fetch a better rate than "non-sharbati" wheats.

(6) *It is an awned wheat* and therefore is specially suitable for cultivation in tracts where there is much risk of damage by birds or locusts, *e.g.*, in Lower Sind.

Description of Pusa 114 wheat.—Pusa 114 wheat is an awned wheat, bearing black awns. It is a tall, upright plant with strong straw. The earhead is semi-compact and the glumes are hairy and red in colour. The grain is small in size, but round and plump. The colour of the grains is deep amber (sharbati) and the wheat is classed as a "strong quality wheat".

The Agricultural Department in Sind is prepared to assist any zamindar desirous of cultivating Pusa 114 wheat on his own lands, to obtain seed at reasonable rates. Applications for such assistance should be submitted as soon as possible to the nearest officer of the Agricultural Department in Sind or to the Botanist in Sind, Agricultural Research Station, Sakrand. As the supply of seed is at present limited, such applications must be dealt with in order of receipt. Arrangements are in force for the rapid extension of the seed-supply of Pusa 114 wheat in Lower Sind where, on account of its "rust" resistance, it should prove of great value to the growers.

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PEDIGREE SEED FOR THE GRASSLANDS OF THE EMPIRE

TWENTY-SEVENTH REPORT OF THE IMPERIAL ECONOMIC COMMITTEE

Improvement in pastures is one of the many difficult problems connected with the improvement of live stock in India. The pasture problem in India possesses special economic and climatic features of its own, but it is fundamental to the maintenance of quality in stock, and the progress made in other countries cannot fail to suggest lines of development from which India may ultimately benefit. For this reason the latest report of the Imperial Economic Committee (*Grassland Seeds*: published for the Committee by H. M. Stationery Office, price 1/-) should be of interest to all those who are concerned with cognate problems in India.

The importance of pedigree seed for pasture plants is the main burden of the report. Even in those parts of the Empire where acclimatization of species remains the major problem, increasing attention is being given to the improvement of strains. The report points out that the close study of grassland seeds and the production of pedigree strains, although comparatively recent developments in agricultural science, are of the first importance for the improvement of pastures, and thereby for the well-being of the live-stock industries. Systematic trials in a number of countries have shown that grasses and clovers are highly sensitive to the influences of evironment, and that several local strains developed from old pastures are, for their own localities, much superior in leafiness and persistency to ordinary commercial seed. Yet regional strains are only the first stages in the advance. Still better results are shown by the pedigree strains now being produced at plant breeding stations, and it is on these pedigree strains that the future of herbage seed improvement chiefly depends.

If, however, economic benefit is to be gained from the work of the plant breeder, far-reaching changes in organisation will be needed. The primary task is that of ensuring an adequate supply of stock seed of the pedigree strains and of maintaining those strains true to type when they pass in commercial quantities through the ordinary channels of trade. This two-fold problem will require, says the report, the united attention of plant breeding stations, seedsmen, farmers and agricultural departments.

Certification of seed crops.—In this connection the report gives particulars of certification schemes and other methods which have been adopted in some countries, notably in Sweden, Canada, New Zealand and (as far as some clovers are concerned) in the United Kingdom, to ensure that the pastoral farmer shall have greater certainty that the seed he buys is of a strain best suited to his local conditions.

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PLANT QUARANTINE RESTRICTIONS IN ARGENTINA AND BELGIUM.

We are indebted to the Bureau of Plant Quarantine of the United States of America for the following summaries of the Plant Quarantine Import Restrictions of the Republic of Argentina and of the Kingdom of Belgium:—

PLANT QUARANTINE IMPORT RESTRICTIONS OF THE REPUBLIC OF ARGENTINA

Authority Act

Law No. 4084, July 8, 1902, authorizes the Executive of the Argentine Republic to permit the importation of plants and seeds through such ports as he may designate. Plants and seeds, prior to entry, are subject to inspection, and, when necessary, to disinfection or destruction as established by the regulations.

Concise summary

Importation prohibited

Bamboo plants or parts thereof, including all genera and species of the tribe Bambuseae. (Decree of March 31, 1919.) (See page 8.)

Corn (*Zea Mays*), both grain and plant in any state, including that used for packing merchandise. (Decree of May 11, 1927.) (See page 8.)

Broomcorn, including seed and dried plant for industrial purposes. (Decree of May 11, 1927.) (See page 8.)

Bananas and plantains, plants and shoots. (Ministerial Resolution of August 28, 1928.) (See page 9.)

Guavas: Importation of the fruit prohibited. (Decree of March 9, 1931. Article 9.) (See page 11.)

Cottonseed of the species *Gossypium barbadense* and *G. peruvianum*: Introduction into the Territory of Chaco not permitted. (Decree of July 28, 1931.) (See page 13.)

Seeds of Sudan grass, sweet sorghum, and any other species of sorghum which contain seeds of *Sorghum halpense.* Importation prohibited. (Decree of March 7, 1932.) (See page 20.)

Gramineous and leguminous seeds which fall below the established tolerances of germinability and purity are prohibited entry. (Decree of March 7, 1932.) (See pages 19 to 21.)

Seeds of the genera: Medicago, Trifolium, Astragalus, Lotus, Melilotus, and *Lupinus* if found infested with *Bruchophagus funebris* or *B. gibbus*, are prohibited entry. (Decrees of July 5, 1915, and March 7, 1932, as amended by that of July 29, 1932.) (See page 21.)

Importation restricted

Live plants, parts thereof, and seeds: Each consignment must be accompanied by a shipper's declaration of origin and a phytosanitary certificate (inspection certificate) issued by competent authority of the country of origin, and visaed by the Argentine Consul nearest the place of embarkation. Upon arrival at the port of entry in Argentina the consignment will be subject to inspection and to action in accordance with the result of the inspection. (Decrees of August 23, 1902, May 6, 1932 and July 7, 1933.) (See page 3 *et seq.*)

Sugarcane: Each consignment to be accompanied by a certificate of origin issued by competent authority of the country of origin and visaed by the Argentine consul. If admitted, the cane shall be quarantined for observation. (Decree of March 17, 1919.) (See page 15.)

Potatoes: Each consignment shall be accompanied by a certificate of "healthy origin" and of "health", visaed by the Argentine consul (Decree of July 12, 1923), and may be imported subject to inspection and the restrictions prescribed in the general regulations under the Decree of August 23, 1902. (Decrees of July 12, 1923, and October 3, 1930.) (See page 13.)

Seeds of plants which may be attacked by the European corn borer (*Pyrausta nubilalis*) may be introduced only through the port of Buenos Aires, and must be fumigated with hydrocyanic acid gas in vacuum. (Decree of May 11, 1927.) (See page 8.)

Seeds for industrial purposes. The Direction General of Agriculture and Agricultural Protection is authorized to permit the introduction of seeds intended for industrial purposes without the disinfection required by Article 2 of the Decree of May 11, 1927. (Decree of March 7, 1931.) (See page 9.)

Fresh fruits: Each consignment must be accompanied by a phytosanitary certificate issued by authorized technical officials of the country of origin and visaed by the Argentine consul. (Decrees of March 9, May 19, and July 14, 1931, April 8, 1932, February 24 and July 7, 1933.) (See page 9 *et seq.*)

Apples and pears from New Zealand: Importation authorized through Montevideo. (Decree of June 30, 1931.) (See page 13.)

Cottonseed: Clean seed in soldered metal containers will be permitted from any source up to 10 kilograms of each variety for experimental sowing by the Direction General of Agriculture and Agricultural Protection, subject to disinfection *in vacuo* before shipment and upon arrival in Argentina. (Decrees of June 30, and July 28, 1931.) (See page 13.)

Gramineous and leguminous seeds may be imported if found within the established tolerances of germinability and purity. (Decree of March 7, 1932, as amended by that of July 29, 1932.) (See page 15 *et seq.*)

Importation of plants, seeds, and fruits

General regulations

The following regulations were promulgated by the Decree of August 28, 1902:

Authorised ports of entry

Article 1.—Plants. Buenos Aires. (Decree of August 28, 1902.) The ports indicated below were authorized by subsequent decrees as indicated:

Plants: Bahia Blanca. (Decree of August 31, 1911.)

Plant products from Chile via Cordillera: Rosario. (Decree of October 30, 1926.)

Plants of the genus Citrus: Corrientes. (Decree of April 30, 1907.)

Seeds: Buenos Aires, Bahia Blanca, and Rosario. (Decree of July 5, 1915.)

Foreign seeds for sowing on the Experimental Farms of the Faculty of Agriculture, Live Stock and Related Industries: Corrientes. (Decree of January 26, 1922.)

Fresh fruits: Buenos Aires and Rosario. Consignments imported through Mendoza, Posadas, and La Quiaca will be cleared at Buenos Aires. (Decree of March 9, 1931.)

Apples and pears from New Zealand: Montevideo. (Decree of June 30, 1931.)

Potatoes: Buenos Aires. (Decree of July 12, 1928.)

Rice: Pasos de los Libres. (Decree of June 23, 1922.)

Import permits required

Article 2.—Any person in Argentina who desires to import live plants, parts thereof, or seeds, must apply to the Oficina de Sanidad Vegetal for a permit, furnishing the following information:

(*a*) Name and address of importer.

(*b*) Name of plant or seed.

(*c*) Origin of the same, supported by *the declaration of the seller and a certificate of competent authority.*

(*d*) Means by which the consignment will be imported (steamer, railroad, etc.).

(*e*) Purpose for which imported (planting, sale, sowing, consumption).

(*f*) When possible, the locality where it will be planted or sown.

Treatment of infected or suspected plants

Article 3.—All plants, or parts thereof, which proceed from countries where any infection injurious to the agricultural interests of Argentina exists, or into which the introduction of plants may not have been regulated, shall be considered suspicious, and as such, be subjected to the treatment and disinfection deemed necessary by the Oficina de Sanidad Vegetal.

Article 4.—All plants, or parts thereof, found to be attacked by any readily communicable injurious infection shall be refused entry or destroyed by fire if they cannot be effectively disinfected. Destruction shall not give rise to indemnification. If exportation is decided upon it must be effected immediately by the person concerned.

CONDITIONS OF RELEASE FOR ENTRY

Inspection certificate required

Article 5.—Plants or parts thereof which are not deemed suspicious and which are not attacked by injurious diseases, or which are accompanied by health certificates issued by competent authority of the country of origin and visaed by the Argentine consul nearest to the place of origin, shall be admitted after the usual inspection.

The Decree of May 6, 1932, as amended by that of July 7, 1933, prescribes that every consignment of plants or parts thereof intended for propagation or for consumption shall be accompanied by an inspection certificate issued by competent authority of the exporting country and visaed by the Argentine consul nearest to the port of embarkation, in order to be admitted into Argentina, but this requirement does not exempt such consignments from the inspection, quarantine, rejection, and other provisions of Law No. 4084 and its regulatory decrees.

Article 6.—For the present, plants from countries infested with phylloxera and San Jose scale are declared to be of suspicious origin for the purpose of Article 3. Protective measures will be prescribed for other infections if deemed necessary.

Article 7.—Plants and parts thereof which in accordance with Article 3 are declared suspicious, are divided into the following categories for treatment: (*a*) Live plants and cuttings; (*b*) bulbs, tubers, and roots; (*c*) fruits and vegetables; (*d*) seeds.

Article 8.—For treatment, live plants are divided into two groups: (1) Plants with earth; (2) plants without earth. Plants with earth will have their aerial parts disinfected; the subterranean parts and the soil will be treated with insecticides. Plants without earth, and cuttings, will be completely disinfected in all their parts by immersion or by exposure for a sufficient time to the action of disinfectant fumes.

Article 9.—Bulbs and turions (young scaly shoots, pips) must be deprived of all their dead membranes (skin) and appendages, as well as of the adhering soil, and be subjected to a disinfectant wash before being admitted. Tubers and roots will be admitted if found to be sound and free from soil, otherwise they shall undergo a disinfectant wash or fumigation before being admitted.

Fruits and vegetables

Article 10.—This article is superseded by the Decree of March 9, 1931, as amended, which regulates the importation of fruits and vegetables into Argentina.

Seeds subject to inspection

Article 11.—Seeds admitted into Argentina in great or small quantities also shall be inspected by the Phytopathological Service (Oficina de Sanidad Vegetal), which will permit unrestricted entry, require disinfection, or absolutely refuse entry in accordance with the results of the inspection in each case to determine the character of the impurities they contain. (Decrees of July 5, 1915; March 7, 1932; and July 29, 1932.)

Articles 12 and 13.—Concern applications for import permits for plants and seeds.

Article 14.—The inspection, and the disinfection which may have been required, having been accomplished, a certificate will be issued to the applicant to enable him to withdraw his plants or a portion of them.

Articles 15 and 16.—Concern the disposal of smuggled plants, etc.

Inspection and certification

The inspection and certification of plants or parts of plants offered for entry into the Argentine Republic, whether for propagation or consumption, is prescribed by the decree of May 6, 1932, as amended by that of July 7, 1933, as follows:

Article 1.—Every consignment of plants, or parts of plants, intended for propagation or consumption, with the exception of the classes of products listed below, shall be accompanied by a phytosanitary certificate issued by competent authority of the exporting country and visaed by the Argentine consul nearest the place of embarkation, in order to be admitted into the country.

The following classes of products are exempt from the presentation of the said certificate:

(*a*) Those which have been subjected to a process of industrialization (other than cooking): Provided, that they come in suitable containers (prunes, dates, figs, and similar cured or dried products);

(*b*) those which arrive for immediate roasting (coffee, cocoa, and similar products):

(*c*) products that result from milling (various flours, mill feeds, split or rolled grains, and similar products);

(*d*) products intended for the cultivation of orchids and other analogous purposes, as well as those intended for pharmaceutical uses (dry fibres, mosses, medicinal plants, and similar products);

(*e*) those which arrive by international parcel post.

Article 2.—The requirement of the preceding article does not exempt any consignment of plants or their parts from the sanitary inspection, quarantine, rejection, or other requirements of Law 4084 and its regulatory decrees, with the exception of the classes of products indicated in continuation, which shall, at the same time, be exempt from the general quarantine inspection since, arriving in the condition specified, they cannot be carriers of pests:—

(*a*) those which come in a suitably preserved condition (syrup, brine, and other similar products);

(*b*) those which have been subjected to a process of cooking and arrive in hermetically closed containers (peas, asparagus, tomatoes, and similar products).

Article 3.—The text of the phytosanitary certificate may be that established as a standard in the International Convention for Plant Protection, Rome, 1929, or one of similar content, and it must indicate at least, the name of the exporter and of the consignee, class of product, place and date of issuance of the certificate.

The certificate adopted as a standard in the International Convention for Plant Protection is as follows:

Certificate of inspection and origin

The undersigned (full name, official title, and address of agent authorized to issue the certificate) certifies, in conformity with the results of the inspection

NOTE:—It is understood that certification is required of rice and similar cereals, and of raisin and nuts, as well as of plants and parts thereof.

(1)* of the cultures of origin; (2)* of the products included in the shipment, that the plants, or parts of plants, described below are deemed free from dangerous diseases and pests, and especially from those hereafter enumerated.†

Description of shipment

Number, weight, and kind of container.
Marks on the container.
Description of the plants, or parts of plants.
Locality where grown.
Full name and address of shipper.
Full name and address of consignee.
Place and date of issuance of certificate.

Plants brought in by passengers

Plants brought in by passengers will be subject to the general sanitary provisions set forth in the Decree of August 23, 1902. (Decree of August 13, 1917.)

BAMBOO PROHIBITED ENTRY

The introduction of plants and culms of bamboo of all genera and species included in the tribe Bambuseae is prohibited, to prevent the introduction of bamboo smut (*Ustilago shiraiana*). (Decree of March 31, 1919.)

Importation of corn (Zea Mays) *prohibited*

The importation of any variety of maize is prohibited, not only of the grain, but of the plant in any state, including that used as packing; and also the importation of broomcorn, either the seed or the dried plant for industrial uses, grown in any part of the world.

Seeds of plants which may be attacked by the European corn borer (*Pyrausta nubilalis*) may be imported only through the port of Buenos Aires. Although these seeds may be apparently in good sanitary condition, they must be subjected to a thorough disinfection in a vacuum for a minimum of four hours with the strongest possible quantity of hydrocyanic acid gas.

The list of plants attacked by the European corn borer is as follows:

Plants severely attacked

Hemp (*Cannabis sativa*).
Hops (*Humulus japonicus*).
Rhubard (*Rheum rhaponticum*).
Dahlia.
Sorghum.
Millet (*Echinochloa crusgalli edulis*).

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*Strike out the clause not required by the importing country.

†The indication of the names of plant diseases and pests enumerated in the official list of the importing country, and against which that country especially desires to protect itself, will be completed by the indication of any other special condition contingently required by the said country.

Plants frequently attacked

Barley (*Hordeum vulgare*).
Beans (*Phaseolus spp.*).
Beets (*Beta vulgaris crassa*).
Celery (*Apium graveolens*).
Chrysanthemum.
Cotton (*Gossypium hirsutum*).
Potatoes (*Solanum tuberosum*) (not seed potatoes).
Spinach (*Spinacia oleracea*).
Sunflower (*Helianthus annuus*).
Cowpeas (*Vigna sinensis*).
Peppers (*Capsicum annuum*).
Buckwheat (*Fagopyrum vulgare*).
Artichokes, Jerusalem (*Helianthus tuberosus*).
Oats (*Avena sativa*).
Tomatoes (*Lycopersicum esculentum*).

(Decree of May 11, 1927.)

The Direction General de Agricultura y Defensa Agricola is authorized to permit the introduction of seeds intended for industrialization (manufacturing purposes), exempting them from the disinfection in vacuum prescribed by Article 2 of the Decree of May 11, 1927. Such seeds shall unfailingly be processed in the establishment of the importing firm under the direct supervision of the Phytosanitary Office of Importation and Exportation of Plants and Seeds (Oficina Sanitaria de Importacion y Exportacion de Plantas y Semillas), which shall in each case insure the complete industrialization of the shipments to prevent the germs with which they may be attacked from being distributed in the cultures of the country. (Decree of March 7, 1931.)

BANANAS AND PLANTAINS PROHIBITED ENTRY

The introduction of plants and shoots of bananas and plantains into Argentina is prohibited as a precaution against the introduction of the fungus *Fusarium cubense* and other diseases of the banana. (Decree of August 28, 1928.)

REGULATIONS GOVERNING IMPORTATION OF FRESH FRUITS

Article 1.—Every consignment of fresh fruits imported into the country shall be accompanied by a phytosanitary certificate (inspection certificate), without which it will not be admitted. By phytosanitary certificate is understood that issued by technical officials authorized by the government of the country of origin, in which it is affirmed that the fruits are found to be apparently free from parasites, and which indicates the kind of fruit and name of the variety, the locality where grown (province, state, etc.) the point of shipment, the vessel on which transported, the name of the consignee or of the representative of the forwarding agent in the port of destination (port of arrival in Argentina), and the date of issuance of the certificate. This certificate must be visaed by the respective Argentine consular official at the port of shipment or at the nearest point.

Article 2.—The importation of fruit in bulk is prohibited, with the exception of bananas. The packing shall be done in the port of origin and the containers shall be of the standard types adopted by the fruit exporting countries.

Apples, pears, oranges, mandarins, and lemons shall be wrapped in impermeable paper of silky texture (oiled manila or sulphite or similar paper) on which the name or mark of the producer and the country of origin shall be printed. The containers shall be marked to indicate the character of the contents, class or variety, net weight or number of units, name and address of the grower, and the country of origin. (See exception in favour of barrelled apples, decree of February 24, 1933.)

Article 3.—Consignments of fruits introduced into the country will be inspected at the ports of arrival in accordance with the regulations under Law No. 4084. If inspection of the fruit reveals ample reason for suspecting them to be infested with any of the parasites indicated in Article 4, the consignment will be placed in quarantine, for such period as is deemed necessary by the Phytosanitary Office of Plant and Seed Importation (Oficina Sanitaria de Importacion y Exportacion de Plantas y Semillas), in localities indicated by the importers, and which in the opinion of the Office in question meets the required conditions. If, as a result of the investigation carried on during the quarantine period, the existence of the parasites mentioned in Article 4 is not established, the consignment will be released to the interested person.

Article 4.—In the event that any of the following parasites are found in a shipment, the entire consignment will be incinerated without right of indemnity, and the cost of transportation to the incinerator shall be borne by the importer.

List of parasites

Apple blotch, *Phyllosticta solitaria;* citrus canker, *Bacterium citri;* brown rot, *Pythicaystis citrophthora;* soft rot, *Thielaviopsis paradoxa;* mediterranean fruit fly, *Ceratitis capitata;* apple curculio, (*Anthonomus*) *Tachypterellus quadrigibbus;* an apple fruit miner, *Enarmonia prunivora;* apple maggot, *Rhagoletis pomonella;* apple weevil, *Pseudanthonomus crataegi;* plum curculio, *Conotrachelus nenuphar;* orange tortrix, *Tortrix citrana;* orange holcocera, *Holcocera iceryaeella;* orange platynota, *Platynota tinctana;* Arizona navel orange worm, *Myolois venipars.*

Article 5.—Fruits found to be attacked by other parasites known to be injurious, not included in the preceding Article, will be rejected, and in case they cannot be reshipped, they will be incinerated as provided in Article 4.

Article 6.—The importation of fruits may be effected only through the ports of Buenos Aires and Rosario. Consignments imported through Mendoza, Posadas, and La Quiaca will be cleared at Buenos Aires or Rosario. The customs will seal the cars on entry into Argentine territory. This procedure will remain effective until quarantine and disinfection services have been organized at the frontier.

Article 7.—This article originally provided for the entry of the fruits named therein during certain periods of each year, but it was revoked by the Decree of April 8, 1932, thus, in effect, providing for the introduction of fruits and vegetables at any period of the year.

Article 8.—The importation of guavas is prohibited.

Article 9.—Every consignment of apples and pears imported must be transported in refrigeration chambers. (Decree of March 9, 1931.)

The importation is permitted of apples and pears in bushel baskets or in barrels of standard type. The paper wraps for these fruits shall be stamped (or printed) with the mark or name of the packers or exporters. (Decrees of May 19, and July 14, 1931, and February 24, 1933, exempting barrelled apples from the U. S. from the requirement of paper wrappers.)

The weight or volume of the contents shall be declared in the metric system on each container. (Decree of September 18, 1931.)

Paper wrappers not required for barrelled apples from the United States

Decree No. 17614, of February 24, 1933, modifies that of March 9, 1931, by exempting barrelled apples exported from the United States to Argentina from the requirement of a waterproof tissue-paper wrapper for each apple.

Article 1.—Article 2 of the decree of March 9, 1931, is modified, in so far as it refers to the requirement of wrapping in waterproof stamped tissue-paper each North American apple introduced into Argentina in barrels.

Article 2.—Barrelled apples which it is desired to introduce into Argentina must be accompanied by an inspection certificate issued by competent authority of the respective State, and by a second certificate issued by exports of the United States Department of Agriculture. These certificates must be presented to the Argentine consul nearest to the point of embarkation for authentication of the signatures.

Article 3.—Ten per cent. of the containers of every shipment of apples not exceeding 500 barrels, and eight per cent. of the containers in excess of 500 barrels, shall be opened, without exception, for the customary inspection, at a place indicated by the Oficina Sanitaria de Importacion y Exportacion de Plantas y Semillas.

Article 4.—The inspection certificates shall make special mention of the diseases and pests indicated in regulation 4 of the decree of March 9, 1931.

Article 5.—The only ports authorized for the entry of fruits under the provisions of this decree are Buenos Aires, Rosario, and La Plata.

Apples and pears from New Zealand

Subject to the provisions of Article 9 of the Decree of March 9, 1931, the importation is authorized of consignments of apples and pears from New Zealand, transhipped at Montevideo to vessels of the Compania Argentina de Navigation Ltd. (Decree of June 30, 1931.)

Restrictions on cottonseed

The importation of cottonseed is permitted from any source under the following conditions:

1. Only clean seed, free from linters and adhering fibre, may be imported.

2. Containers shall be metal, completely soldered.

3. Before shipment each consignment shall be disinfected in vacuum and shall be accompanied by a certificate to that effect, issued by authorized technical officials of the government of the country of origin, and visaed by the respective Argentina consul.

4. The seed shall be disinfected in vacuum again on arrival in Argentina. (Decree of June 30, 1931.)

5. The quantity is limited to 10 kilograms of each variety and the seed may be imported only for experimental sowing under the supervision of the Direction General of Agriculture and Agricultural Protection.

6. The introduction into the Province of Chaco of cottonseed of varieties of the species *Gossypium barbadense* and *G. peruvianum* will not be permitted.

7. When it is desired to introduce cottonseed of long staple varieties, upland type (intermediate), for planting in Chaco, in addition to the provisions of the Decree of June 30, 1931, a certificate of origin is required indicating the name of the variety and place of production. The Direction General will decide whether or not it is proper to permit its introduction for such purpose. (Decree of July 28, 1931.)

Regulations governing the importation of potatoes

Certificates required

Each consignment of potatoes imported into Argentina from a foreign country shall be accompanied by a certificate of sanitary origin and by a phytosanitary certificate (inspection certificate).

These certificates shall be issued by specialists authorized by the government of the country of origin.

The certificate of sanitary origin shall certify that the planting or ground in which the potatoes were grown is in good sanitary condition and shall indicate the date of digging, the quantity or weight of the potatoes represented by the certificate, and the name of the grower and of the consignee.

The phytosanitary certificate shall affirm that potatoes are found apparently free from pests and diseases; indicate the quantity or weight, marks, name of the vessel on which shipped, the name of the consignee or representative of the shipper, the country of destination, and the date of issue. The inspection upon which the certificate is based shall not be made until at least one month has elapsed after the date of the certificate of sanitary origin.

The above-mentioned certificates shall be visaed by an Argentine consul, and the potatoes shall be inspected at the port of arrival in Argentina.

If inspection shows the potatoes to be in good sanitary condition their entry will be permitted, but if as a result of the inspection not exceeding 10 per cent. of the tubers are found to be attacked by any pest, or by any disease of an infectious character, a selection and separation of the tubers will be effected, infected tubers being destroyed and the remainder disinfected, at the expense of importer.

If the percentage of infected tubers is greater than 10, the importer may elect to have them reladen or to have them incinerated at his own expense within three days of notification.

Any shipment of potatoes which arrives infested with a parasite which does not exist in Argentina will be rejected and the importer must immediately relade it or have it incinerated.

The only authorized port of entry for potatoes is Buenos Aires. Consignments of potatoes not accompanied by the required certificates will not be admitted. (Decree of July 12, 1923.)

Shipments of potatoes offered for entry into Argentina will be subject to the inspection and other procedure prescribed in the general regulations under Law No. 4084, as set forth in the Decree of August 23, 1902. (Decree of October 3, 1930.)

Sugarcane

Article 1.—Every shipment of sugarcane plants or cuttings offered for introduction into Argentina, besides meeting the general conditions, shall be accompanied by a certificate of origin issued by competent authority and visaed by the Argentine consul in the country of origin. If not bearing the said certificate, the shipment shall be rejected by the sanitary authorities.

Article 2.—Besides the above-mentioned certificate, and, with or without it, every shipment of sugarcane plants which reaches Argentina for importation shall be subjected to a quarantine during which the sanitary observations and operations which the technical offices deem necessary shall be carried out, to guarantee the purposes upon which this resolution is based, namely, to prevent the introduction of pests and diseases of the sugarcane. (Decree of March 17, 1919.)

Importation of plants of Yerba Mate prohibited into the Province of Tucuman

The Governor of the Province of Tucuman, by the Decree of June 12, 1929, prohibited the importation into that Province of Paraguay tea (yerba mate, *Ilex paraguensis*) of any variety from any source. The importation of the seeds

of this plant will be carried out by the Agricultural Experiment Station of Tucuman, subject to disinfection with a 2 per cent. caustic potash solution for 12 hours.

Restrictions on the importation of leguminous and gramineous seeds

The Decree of July 5, 1915, provides for the sampling of leguminous and gramineous seeds offered for entry into the Argentine Republic, and for the issuance of certificates of analysis based upon samples withdrawn from each shipment.

The same decree provides for the cleaning of shipments of such seeds which fall below the prescribed tolerances of germinability and purity and prescribes that seeds which, after being cleaned, still remain below the established tolerances, shall be re-embarked or destroyed without right of indemnity.

The decree of March 7, 1932, supplements that of July 5, 1915, by modifying and extending the scope of the latter. The text of the decree of July 15, 1915, as amended by that of March 7, 1932, follows:

Articles 1, 2, and 3.—Revoked by the decree of March 7, 1932.

Article 4.—Certificates of analysis of alfalfa seed relating to the established tolerances will be issued:

(*a*) Not certifying more than the conditions found "within the tolerances and fit for sowing", in cases where the alfalfa seed does not contain more "Cuscuta" and "other harmful seeds", or lower "cultural value" than is tolerated (see Article 3 of the decree of March 7, 1932), nevertheless being able to indicate the percentage of germination in order to illustrate better to the interested person.

(*b*) When alfalfa seeds exceed one of the established tolerances they will be indicated as "beyond the limits of toleration".

(*c*) The "number of Cuscuta seeds', percentage of "other harmful seeds", "germinability", or freedom from Cuscuta or other harmful seeds, and "as possessing the guaranteed cultural value" will be certified; it will also be indicated whether or not they are fit for sowing in accordance with the tolerances established by Article 3 of the decree of March 7, 1932, when alfalfa seed is offered for sale under guaranty of "absolute purity", or with the minimal purity by specifying in terms of "Cuscuta" or "other harmful seeds" and "cultural value" not inferior to the guaranty and within the established tolerances, for which the corresponding sample must be delivered to the Direccion General de Agricultura y Defensa Agrícola, sealed and signed by the vendor and purchaser or interested person, by witnesses who represent or accept the parties, or by officials of the Department of Agriculture, whose testimony shall accompany the sample, as likewise a copy of the guaranty, which shall be filled in the said division in cases in which it is necessary to mediate as arbitrator.

Article 5.—The ports authorized for the importation of alfalfa seeds are Buenos Aires, Rosario, and Bahia Blanca.

Article 6.—The ports authorized for the importation of seeds are those indicated in the preceding article. This applies to all classes of seeds.

Article 7.—An application will be presented by the importer or his representative for each importation of seeds; the application shall indicate the origin, the name of the exporting firm, kind and quantity by weight, numbers and marks of the containers of the seed, name of vessel on which it will arrive, port of arrival, name and address of consignee. The application, accompanied by the certificates of origin, health, and disinfection which the shipments bear, will be delivered to the Oficina Sanitaria de Importación de Plantas in the port of entry, or in the absence of such an office, to an official of the Dirección de Defensa Agrícola y Sanidad Vegetal, who is in charge of importation and exportation, and in case one has not been designated, to the Collector of Customs at the said port, who will proceed to draw samples; sending them direct to the "División de Fomento" of the said Direction, with the corresponding documents, for analysis and the issuance of the certificate, and in which, upon the origin of the sample from the corresponding shipment being attested, the dock orpier and the depository in which it is found, will be indicated in order that the transmittal of the certificate of analysis may be made direct to the chief of the latter, from which will be decided whether or not the importation will be permitted.

Article 8.—In cases where certificates of analysis of shipments of alfalfa seed to be imported shall indicate a "Cuscuta content" and "cultural value" greater and less, respectively, than the tolerances (established by Article 3 of the decree of March 7, 1932), the importers or duly authorized representatives may elect the relading, destruction without indemnity, or an attempt to clean the seed (decuscutage), and the winnowing in a warehouse or depository authorized by the Ministry for those operations, in order to try to obtain the tolerated percentages, for which purpose the entry for clearance through the customs and the treatment of the corresponding seed will be permitted under the custody of the customs officials and for the account of the importer.

During the operations, whatever the result may be, the residuum will be burned as produced without giving rise to any indemnity; since the interested person or his duly authorized representative has resorted to this privilege, he will have abandoned his rights in the application which had to be made for cleaning.

If, as a result of the cleaning or winnowing, tolerances are obtained which authorize importation, a delivery order will be issued to the authorized depository for the release of the shipment, the cleaned shipment thus being definitely admitted, and a record will be left in the corresponding file of the operations and analyses effected, etc.

In the event that the attempts to clean do not yield the results sought, the interested person will be notified of the results of the analysis and a relading

order will be issued through the customs authorities, unless destruction is authorized in writing by the Oficina Sanitaria de Importación de Plantas y Semillas, in which case, besides the record in the file, the office mentioned will issue to the authorized depository a certificate of release for destruction.

If, after the lapse of 15 days from the date of notification of the interested person, none of the procedures above indicated has been followed, it will be deemed that he has abandoned his rights and the office menticned will proceed to destroy the seed by burning and will make affidavit accordingly.

Article 9.—The entry and the relading of shipments of alfalfa seeds for cleaning, discussed in the preceding article, will be authorized through the port of Buenos Aires only.

Article 10.—(As amended by Article 4 of the decree of March 10, 1926): The introduction into the country of seeds of toothed bur clover, *Medicago (denticulata) hispida*, and spotted bur clover, *Medicago (maculata) arabica*, is prohibited.

The text of the decree of March 7, 1932, which amends and supplements that of July 15, 1915, follows:

Article 1.—Subject to the provisions of Law No. 4084, the importation of seeds of forage plants is prohibited, as detailed in Article 2, when from the physico-botanical analysis which will be made in each case by the Direction of Agricultural and Animal Industry Laboratory and Research (Direction de Laboratorio e Investigacines Agrícolo-Ganaderas), it is deduced that they are adulterated or of inferior quality for sowing, in accordance with the present regulations.

Article 2.—The Direction of Agriculture (Dirección de Agriculltura), in accordance with the provisions established by the decree of July 15, 1915, which is maintained in so far as it is not opposed to the present decree, will proceed with the withdrawal of samples from shipments of seeds of leguminous and gramineous forage plants which are imported:

LEGUMES: *Anthyllis vulneraria*, sand clover; *Hedysarum coronarium*, French honeysuckle: *Lotus corniculatus*, birdsfoot trefoil; *Lotus uliginosus*, British bog lotus; *Medicago lupulina*, yellow trefoil; *Medicago sativa*, alfalfa. *Melilotus alba*, white sweet clover; *Melilotus alba* var. *annua*. Hupam clover; *Ornithopus sativus*, serradella; *Onobrychis viciaefolia*, sainfoin; *Trifolium alexandrinum*, Alexandrian clover; *Trifolium fragiferum*, strawberry clover; *Trifolium hybridum*, alsike clover; *Trifolium incarnatum*, crimson clover; *Trifolium pratense* red clover; *Trifolilum repens*, white cover.

GRASSES: *Agrostis (alba) palustris*, redtop; *Alopecurus pratensis*, meadow foxtail; *Arrhenatherum elatius*, tall oatgrass; *Avena* spp., oats; *Bromus inermis*, common bromegrass; *Bromus unioloides*, rescue grass; *Chloris gayana*, Rhodes grass; *Capriola (Gynodon) dactylon*, Bermuda grass; *Cynosurus cristatus*, crested dogtail; *Dactylis glomerata*, orchard grass; *Eragrostis abyssinica*, teff; *Festuca pratensis*, meadow fescue; *Festuca ovina*, sheep's fescue; *Festuca rubra*, red

fescue; *Hordeum vulgare*, barley; *Lolium (italicum) multiflorum*, Italian ryegrass; *Lolium perenne*, perennial ryegrass; *Panicum miliaceum*, broomcorn millet; *Phalaris stenoptera*, Peruvian winter grass, *Phleum pratense*, timothy; *Poa pratensis*, Kentucky bluegrass; *Poa trivialis*, rough bluegrass; *Secale cereale*, rye; *Chaetochloa (Setaria) italica*, millet; *Holcus sorghum (vulgare) var saccharatus*, sweet sorghum; *Holcus sorghum (vulgare)* var. *sudanensis*, Sūdan grass.

Article 3.—Leguminous seeds will be examined for their real value, cultural or for use, and the content of foreign seeds, proceeding to reject every shipment in which the following conditions are found:

(*a*) When the cultural value of alfalfa seed is less than 85 per cent, with a purity of 98 per cent.

(*b*) When seeds of white clover, red clover, crimson clover, alsike clover, strawberry clover, Alexandrian clover, yellow trefoil, French honeysuckle, and sand clover, have a cultural value of less than 75 per cent.

(*c*) When the cultural value of seeds of white sweet clover, Hubam clover, and serradella, is less than 70 per cent.

(*d*) When the cultural value of birdsfoot trefoil, British bog lotus, and sainfoin is less than 60 per cent.

(*e*) When leguminous seeds of any species contain more than 10 cuscuta seeds per kilogram of seed.

(*f*) When they contain more than one half of one per cent by weight of weed seeds, considering as such those corresponding to all species of uncultivated plants, or attest that the seeds have been subjected to a mechanical treatment to modify their appearance or their constitution.

Article 4.—The seeds of gramineous forage plants mentioned in Article 2 will be subjected to a determination of their germinability and content of foreign seed, proceeding to reject those found in the following conditions:—

(*g*) When the seeds of oats, barley, rye, timothy, and tef have a germinability of less than 80 per cent.

(*h*) When the seeds of rescue grass, orchard grass, meadow fescue grass, redtop, ryegrass, broomcorn millet, sweet sorghum, and Sudan grass have a germinability of less than 70 per cent.

(*i*) When the seed of tall oatgrass, common bromegrass, crested dogtail grass, sheep's fescue grass, Peruvian winter grass, and rough bluegrass have a germinability of less than 60 per cent.

(*j*) When the seeds of meadow foxtail, Bermuda grass, red fescue grass, and Kentucky bluegrass have a germinability lower than 50 per cent.

(*k*) When Rhodes grass contains less than 500,000 germs per kilogram of seeds.

Article 5.—All gramineous seeds which contain more than one per cent. by weight, of weed seeds, will be rejected; also when they contain more than 8 per cent. by weight, of seeds of other cultivated species of plants, their importation is still prohibited, even in the case of special mixtures, as forage or for turf.

Mixtures of *Lolium perenne* with *L. italicum* and those of different species of the genus *Poa*, are excepted from these provisions.

Article 6.—The importation of seeds of Sudan grass and sweet sorghum, and of any other species of sorghum which contain fruits of *Sorghum halpense*, is prohibited.

Article 7—No shipment of alfalfa seed may be introduced into the country unless at least one per cent of the contents of each container be colored as follows:—

(1) Alfalfa seed from European countries by an alcoholic solution of crystal violet (1½ per cent.).

(2) Alfalfa seeds from other countries or regions shall be colored with Malachite green (1½ per cent.).

(3) The coloring materials, which may be those above indicated, or others which produce equal coloration to those established, shall be applied in such a manner that the colored seeds are distributed as uniformly as possible throughout the package.

Article 8—Each combined sample taken for analysis in accordance with the provisions of these regulations shall represent not more than 200 sacks or containers of the same mark and shall be withdrawn by taking partial samples in the following proportions —

(1) When the shipment comprises a single lot of 5 containers or less, a sample will be taken from each container to form the combined sample.

(2) In shipments comprising a lot of more than 5 containers and less than 30, a sample will be taken from every second container, but never fewer than 5 containers shall be sampled.

(3) When the shipment comprises a lot exceeding 30 containers and not more than 50, samples will be taken from every third container, but the combined sample shall never be drawn from fewer than 15 containers.

(4) If the lot exceeds 50 containers samples shall be taken from 30 per cent. of them.

(5) When a shipment comprises various lots, samples will be drawn from each lot separately in the manner indicated in sections 1, 2, 3, and 4.

Article 9.—Three combined samples thus formed will be taken; one for the Dirección de Laboratorios e Investigaciones Agricolo-Ganaderas del Ministerio de Agricultura; the second tor the Oficina Sanitaria de la Dirección de Agricultura; and the third will be retained by the interested person, the samples being sealed in the presence of the latter or his representative.

Article 10.—Leguminous seeds of the following genera; *Medicago*, *Trifolium*, *Astragalus*, *Lotus*, *Melilotus*, and *Lupinus*, with all their species, subspecies, varieties and hybrids which may be attacked by the parasites *Bruchophagus funebris* and *B. gibbus* shall come packed in double sacks and be disinfected *in vacuo* before shipment and shall be accompanied by the corresponding certificate of disinfection, issued by technical officials of the country of origin and visaed by the Argentine consul in that country.

Article 11.—(As modified by the Decree of July 29, 1932): in the event that the presence of *Bruchophagus funebris* or *B. gibbus* is noted in shipments of the seeds mentioned in the preceding article in the larval, nymph, or adult stage, they will be at once reembarked, their entry into the country not being permitted.

PLANT QUARANTINE IMPORT RESTRICTIONS OF THE KINGDOM OF BELGIUM

Infested fruits prohibited entry

According to the Ministerial order of July 14, 1933, the importation into Belgium is permitted of fresh peaches, apricots, and nectarines from any source only when an inspection made by the Belgium Plant Protection Service at the expense of the importer shows the shipment to be free from fruit fly larvae (Trypetidae), from caterpillars of the peach twig borer (*Anarsia lineatella*), and of the Oriental fruit moth [*Grapholitha molesta* (=*Laspeyresia molesta*, =*Cydia molesta*)], as well as from larvae of the plum or peach curculio (*Conotrachelus nenuphar*).

Authorised ports of entry

Antwerp, Brussels, Haren-Aviation, Liege, Erquilinnes, Eschen, Montaleux, Mouscron, and Quevy.

Disposal of infested shipments

Shipments arriving at the ports of Erquilinnes, Eschen, Montaleux, Montzen, and Quevy which are found to be infested with any of the above-named pests are to be returned to the country of origin.

Those offered for entry at the ports of Antwerp, Brussels, Haren-Aviation and Liege will be burned at the expense of the importer if found infested.

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Importation of fresh cherries regulated

The decree of the Belgian Minister of Agriculture of May 14, 1932, prescribes that:

1. The importation of fresh cherries into Belgium from France, Germany and Italy is permitted only when an inspection made at the expense of the importer by the Belgian Phytopathological authorities shows the shipment to be free from the cherry fruit fly, *Rhagoletis cerasi*.

2. Importation may be effected only through the customs offices of Erquelinnes, Montaleux (Mouscron), Montzen, Antwerp (office No. 4), and Brussels (offices Nos. 1 and 3).

Shipments arriving at Erquelinnes, Montaleux (Mouscron), and Montzen found to be infested with *Rhagoletis cerasi* will be sent back. Those found at Antwerp and Brussels to be infested with this pest will be burned at the expense of the importer.

Importation prohibited of potatoes, eggplants, and tomatoes from France

The order of the Belgian Minister of Agriculture of April 18, 1932, prohibits the importation into Belgium of potato tubers or plants, and of fruits or plants of eggplants and tomatoes originating or proceeding from France, but admits those products from other countries when each shipment is accompanied by a certificate affirming that the products were grown in a locality free from the Colorado beetle, *Leptinotarsa decemlineata*.

The regulations promulgated under the above order on the same date prescribe that:

The importation of these products from countries other than France is permitted only when a certificate issued by the official plant protection service of the country of origin is presented at the customs office, naming the country of origin of the products, and expressly affirming that they were grown in and proceed from a locality more than 20 km. distant from any culture attacked by the Collorado beetle, *Leptinotarsa decemlineata*, and potato wart, *Synchytrium endobioticum*.

The regulation concerning the distance from foci of infestation with Colorado beetle is compulsory. With respect to foci of potato wart, the importation of potato tubers is permitted when their place of origin is less than 20 km. but not less than 500 meters therefrom, on condition that the certificate in question, in which the circumstances are established, also certifies that the shipment was inspected by the above-mentioned plant protection service and was found free from potato wart.

According to the case, two certificates may be presented one on Colorado beetle, and the other on potato wart.

The re-entry of shipments of this kind also is subject to inspection by the Belgian Phytopathological Service.

Authorised ports of entry

Importation of shipments of these products may be effected by water only through the customs ports of Antwerp, Bruges, Brussels, Ghent, Liege, Ostend, and Zeebrugge.

Shipments not accompanied by the prescribed certificates will be reladen, unless an inspection made by the special Belgian Phytopathological Service at the expense of the importers shows them to be free from Colorado beetle.

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THE MARKET FOR EMPIRE MAIZE

TWENTY-EIGHTH REPORT OF THE IMPERIAL ECONOMIC COMMITTEE

The satisfactory grading of Empire exports of maize is commented on in the report on maize issued by the Imperial Economic Committee (published by H. M. Stationery Office, 1/). Emphasis is also laid on the importance to manufacturers of unbroken weevil-free grain. It is suggested that the export trade would be facilitated and extended if more regular supplies over a longer season could be assured.

The world production of maize and wheat are roughly equal, yet the volume of international trade in maize is only two-fifths of that in wheat and wheat flour. In most producing countries the crop is used locally, chiefly as a food, sometimes mainly for the local population, sometimes for poultry and live-stock. The outstanding example of this is the United States, which produced 60 per cent. of the world's crop in 1932 but contributed less than two per cent. to the world's trade in maize. In sharp contrast to this is Argentina, which, with its smaller population and no large pig industry, supplied two-thirds of the world trade from a crop only one-tenth of that of the United States. Europe, and especially the United Kingdom, the Netherlands, Belgium, France and Denmark and, until 1933, Germany, afford the great market for maize, taking in recent years up to 97 per cent. of the total exported from all countries.

The chief Empire exporting countries are the Union of South Africa, Southern Rhodesia and Kenya. The maize of these countries is mainly a flat white grain very different from the small yellow grain typical of the Argentine crop. The report points out that this flat white maize possesses special advantages for the manufacture of cornflour, custard powders, starch, and glucose. It is also preferred in the distillation of whisky. With this special market, wholesale prices for this Empire maize are, according to the report, usually somewhat higher than for Argentine maize. The difference, however, is neither certain nor constant and the weight of the Argentine crop is such that variations in its price directly affect the prices of African maize. Between 1931 and 1933 these Empire countries experienced special difficulties in the maize trade, owing to the severe depreciation of the Argentine currency and, in 1933 in South Africa, to local drought. The report details the measures taken to assist the local farming community.

Owing to restrictions and regulations in many importing countries, trade in maize, as with so many other commodities, is difficult, but the report notes that the world market is not overshadowed by large accumulated stocks as is the case with wheat. It is important to Empire countries to maintain and extend the market it now has with manufacturers, but that after all is a comparatively small market. The main demand is for poultry food, for which at present small highly coloured grain is preferred. Entry into that market would bring Empire supplies into direct competition with Argentine maize, and a grain more similar to that of Argentina would have to be placed on the market or the present preference broken down as the result of well established trials and publicity.

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DEVELOPMENT OF COTTON GROWING IN SIND

The Publicity Officer, Indian Central Cotton Committee, writes:—

The Annual Report of the Department of Agriculture in Sind for the year 1932-33, just published by W. J. Jenkins, Esq., M.A., B.Sc., I.A.S., Chief Agricultural Officer in Sind, is a highly informative document recording, among other things, the great strides taken in the development of cotton cultivation in Sind and the progress made by the various schemes financed by the Indian Central Cotton Committee, which are directed towards cotton development and improvement in the Barrage areas.

During the year under report, practically the entire new Canal Systems under the Lloyd Barrage were worked during both the *kharif* and *rabi* seasons. Of a total area of 13,67,000 acres on the main Canal Systems in the Barrage areas, cotton occupied about 3,55,000 acres in the *kharif* season The transition from the old system of inundation irrigation to the new Barrage Canal System resulted, according to the Chief Agricultural Officer, in a somewhat unsettled and irregular supply of water in the early months. This caused delay in sowings and reduction in crop areas. The cotton crop in the middle Sind areas was affected by malformation, sterility and bad opening largely due to late sowing.

The Indian Central Cotton Committee held its half-yearly meeting in January, 1933, at Karachi and at its later meeting held in August, 1933, the Committee sanctioned a further grant of Rs. 2,96,540 for the extension of the cultivation of improved varieties of cotton in the Barrage areas A trade exhibition of departmental cottons from Sind was held at Karachi and at Bombay at the time of the Committee's meetings.

BOTANICAL WORK FOR COTTON IMPROVEMENT

The policy, in accordance with the opinion expressed by the Committee when sanctioning an additional grant of approximately three lakhs of rupees for cotton extension work in Sind, has been to concentrate future work on the improvement of Sind cottons upon the medium and long-stapled varieties, *i.e.*, Sind-American and imported American and Egyptian types. The trend of trade demand in India and abroad also justifies such a policy. Insufficient and irregular irrigation during the early part of the season adversely affected the

cotton crop in some parts of Sind. Replicated field scale trials of improved Sind-Americans at Sakrand and Mirpurkhas indicated the superiority of 289 F-1, and 285 F-2 over 285 F-21 in respect of immunity to 'red-leaf'. Selection work among these types to obtain earlier and higher yielding strains with a silkier staple is in progress and a new strain 289 F-20 which was found promising, is being multiplied. Work on types of cotton imported from Russian Turkistan, Africa, Uganda and the United States of America was continued and yielded promising material. Plot trials of numerous selections made by the Agricultural Departments in other cotton growing provinces in India, which were grown at Sakrand, did not reveal any material superior to the improved varieties now being handled by the Agricultural Department in Sind. Hybridization work was limited to the sudy of two crosses, *viz.*, 285 F-1 × Sea Island and 4 F-18 × Meade, which were grown in the F-8 and F-5 generations respectively. The segregates are breeding true for length of staple and high ginning percentage. Samples of their lint are being sent to the Technological Laboratory at Matunga for fibre and spinning tests. Work on the botanical improvement of the long stapled American and Egyptian cottons has been transferred to the Government Seed Farm, Mirpurkhas.

Samples of the improved cottons now being extended in the cotton growing districts of Sind were submitted to the Committee's Technological Laboratory at Matunga and the results obtained compared favourably with those of the previous years.

COTTON PHYSIOLOGICAL RESEARCH SCHEME

The Cotton Physiological Research Scheme, Sind, operating in the extended period of five years, sanctioned by the Indian Central Cotton Committee, has now entered an important stage in its investigations. Particular attention was given during the year under report to discovering the best methods of distributing irrigation supply within a fixed 'delta' to the cotton crop in order to increase final yields. Results obtained indicated that the reduction of intervals between waterings at flowering and fruiting times, *i.e.*, August-September, is beneficial. Investigations on the effect on cotton yields and disease resistance of the application of quick acting nitrogenous manures at critical periods of crop growth are being continued. The factors responsible for the appearance of types of 'red-leaf' condition, the breeding of disease-resistant types, soil conditions in regard to plant nutrition, etc., are being studied. Minor investigations into the control of the white-ant pest and the relationship between the root development of different varieties of cotton and their adaptability to environmental conditions in Sind were also carried out. In view of the prospective extension on a large scale of cotton cultivation in the Barrage areas of Sind, the results of the present investigations conducted under the scheme at Sakrand should be of great economic value.

SIND COTTON EXTENSION SCHEME

The activities covered by the Sind Cotton Extension Scheme, worked by the Agricultural Department, for which the Indian Central Cotton Committee granted a sum of Rs. 31,000 per annum for three years—and which has recently been extended for a further period of five years at a cost of approximately three

lakhs—are being pursued in two sections, one in the Left Bank areas and the other in the Right Bank areas. Each section is under the charge of a Cotton Supervisor. In the Left Bank Section, cotton varietal tests carried on to test the respective yields and suitability for extension of different varieties of cotton on zamindari lands in Thar Parkar, Nawabshah and Hyderabad districts, have again demonstrated the high yielding capacity of the superior improved Sind-American types—289 F-1 and 285 F-2, in the Jamrao tract. Demonstrations of cotton cultivation have been organized in the hitherto non-cotton growing tracts of the Right Bank areas and in Nawabshah district to show the technique and possibilities of cotton cultivation to zamindars. Over 5,000 maunds of seed of improved cotton varieties grown on the lands of registered seed-growers were distributed for extension in the districts by the Cotton Supervisors. In the Right Bank Section—hitherto a non-cotton growing area—the work on thirty demonstration plots, comprising an area of nearly 100 acres on zamindari lands, has brought promising results from 27 W.N. (improved Sind Deshi) and 4 F-18 (an improved Sind-American type). This work has had considerable effect in stimulating private interest in cotton cultivation on the part of zamindars. The Cotton Supervisor, Right Bank, and his staff are giving all possible assistance and advice to intending cotton cultivators in this tract. The report of the Director, Technological Laboratory, Matunga, on tests of samples of cotton grown in the Right Bank areas states that the samples are in no way inferior to similar cottons grown in the long-established cotton growing areas of the Left Bank.

With a potential cotton area of over 800,000 acres in Sind, the work now being carried on under the Scheme to discover the varieties best suited to local cultivation in the different tracts and to extend cotton cultivation, must take a large share in the progressive development of cotton cultivation in the Barrage areas. An important feature of the work has been the effective collaboration between the Department of Agriculture, Sind, and the Publicity Department of the Indian Central Cotton Committee in evolving and carrying out measures designed to accelerate the progress of cotton cultivation in Sind.

The Publicity Officer of the Central Cotton Committee toured at regular intervals in the Sind cotton-growing areas, attended meetings of the Sind Cotton Committee and other organizations and gave valuable expert advice in the propaganda work for the introduction of better and increased cotton cultivation in the province.

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DEVELOPMENT OF CAMBODIA COTTON IN COIMBATORE DISTRICT

The Publicity Officer, Indian Central Cotton Committee, writes:—

The years after 1919 have witnessed an uninterrupted progress in the development of Cambodia cotton in the Coimbatore District by the Department of Agriculture in Madras supplemented by the Seed Multiplication Scheme financed by the Indian Central Cotton Committee. Having regard to the growing demand for improved Indian cotton, the success achieved marks a

step in the evolution of superior varieties of cotton in the Madras Presidency which, in contrast with the state of affairs preceding 1918, deserves the special attention of textile manufacturers in India and growers in South India.

In order to appreciate properly the progress made, it is worth while recalling the deplorable condition of the cotton crop prior to 1918-19. Although an almost fortuitous combination of favourable conditions such as promising season and good rainfall had helped to enhance the prestige of Cambodia cotton which had practically replaced the local Uppam in all the black soil areas in the Coimbatore District, yet years of poor rainfall and the consequent deterioration of the kapas, had witnessed a standing temptation to palm off adulterated kapas, instead of selling good and bad varieties separately. This led to impoverished quality in the supply of sowing seed and complaints from consumers with low quotations. The uneconomical nature of the procedure caused the ryots to fall back upon the indigenous Uppam.

Lines of development

The development and improvement of the Cambodia cotton in the Coimbatore District which thus opened up an immense field of fruitful work began, in its initial stages till departmental seed was available, with the purchase of carefully selected seed cotton out of the arrivals at the ginning factories through a special officer deputed for the purpose, and reselling it during sowing time. The second stage was the formation of an association of growers, sellers and buyers called the "Cambodia Cotton Marketing Association", resulting in the starting of a cotton market at Tiruppur and the fixing of cotton standards to form the basis for all purchases and sales. Unfortunately the former never functioned. The third and most important stage of development was the distribution of seed of selected heavy-yielding strain out of the strains then available in the Central Farm, Coimbatore, to a few good growers in the district on contract.

Inducement to ryots

In pursuance of the policy of supplying seed and marketing the crop under a system of contract with the growers, the Department took opportunity to study prevailing agricultural methods and effect improvements wherever possible and gave free seed for sowing, carried out rogueing while the crop was standing, paid advances (up to Rs. 30 per acre) when the seed was sown for after-cultivation expenses and bought the season's produce at a premium in the villages through a series of agreed undertakings. This arrangement was found necessary in the initial stages in order to reach the growers direct, eliminate the middleman, on whom the grower had to depend for sowing seed, advances and marketing facilities, and thus maintain the purity of the selected strain. The ryots, in their turn, agreed to sow the pure seed (supplied free) in well-farmed lands, to weed the crop and thin it when necessary, to pick the kapas clean, to dry the season's kapas before storing and to remove stained kapas. The growers also agreed to deliver the stored kapas when required by the Department for ginning.

LATER DEVELOPMENT

After two years, with the difficulties of financing and meeting the growing demand for departmental cotton seed, many of these concessions were relaxed and confined only to financing the bare minimum of after-cultivation needs. In the following years the Department undertook to buy only the seed at a premium and acted purely in an advisory capacity in arranging and guiding the growers in the matter of market fluctuations for their lint. After 1925, it was felt desirable to hand over the production of seed to private agencies, and Co-operative Non-Credit Seed Societies in typical villages were accordingly started to answer this purpose. Twelve such societies were started of which eight were eventually transferred to the Co-operative Department. Alongside, new strains, as they were being evolved by the Cotton Specialist, were tried in the villages, and No. 15, Co. 1 (No. 295), and Co. 2 (No. 440) were each successively introduced between the years of 1921 and 1929. The introduction of the Pest Act and the Transport Act had, meanwhile, helped to prevent pest diseases and adulteration, though it must be admitted that owing to the heterogenous nature of the varieties from further south in the Presidency, prevention of adulteration was made more difficult than it need have been.

The Co. 2 Seed Multiplication Scheme, introduced and financed by the Indian Central Committee in 1932-33, is being worked by the Tiruppur Co-operative Trading Society with the object of making available as much of pure Cambodia seed as would meet the needs of all the growers of the district. The financial gain accrues to the grower in two ways, (1) by extra yield, (2) by way of premium through the sale of lint and seed.

Coimbatore, where this development in Cambodia was initiated and systematically carried out, caters to the needs of other districts in the matter of supply of improved seed for sowing.

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THE MAYNARD-GANGA RAM PRIZE

In 1925, the late Sir Ganga Ram, Kt., C.I.E., M.V.O., R.B., Lahore, with that generosity for which he was so well known, handed over to the Punjab Government a sum of Rs. 25,000 for the endowment of a prize of the value of Rs. 3,000 to be called the Maynard-Ganga Ram Prize and to be awarded every three years, for a discovery, or an invention, or a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The competition is open to all throughout the world. Government servants are also eligible to compete for it.

Entries for the next award were invited by the 31st December, 1933. None of the entries was considered to be of sufficient merit and it has been decided by the Managing Committee of the prize that the award should be postponed for another year and that further entries should reach the Director of Agriculture, Punjab, Lahore, on or before the 31st December, 1935.

Applications are invited for "The Maynard-Ganga Ram Prize" of the value of Rs. 3,000 which will be awarded for a discovery, or an invention, or a new practical method tending to increase agricultural production in the Punjab on a paying basis. The prize is open to all, irrespective of caste, creed or nationality and Government servants are also eligible for it. Eassays and theses are not eligible for competition and applicants should prove that some part of their discovery, invention, etc., is the result of work done after the prize was founded in 1925. The Managing Committee reserves to itself the right of withholding or postponing the prize, if no satisfactory achievement is reported to it. All entries in competition for the next award should reach the Director of Agriculture, Punjab, Lahore, on or before the 31st December, 1935.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

Major WALTER LEATHER, V.D., Ph.D., F.I.C.

By the death at his home at Ridgeway House, Malvern, on November 14th, 1934, of Major Walter Leather, Imperial Agricultural Chemist from 1892 until his retirement in 1916, we lose the first scientific officer appointed to what subsequently grew into the Imperial Department of Agriculture in India.

Dr. Leather was first appointed in 1892, the Government of India having decided as a result of Dr. Voelcker's now famous report, that they required the services of an Agricultural Chemist. There are still many officers of the Indian Agricultural Service serving in India who remember him with affection and gratitude, and Indian Agricultural Chemists trained by him are to be found in responsible positions throughout the country. A distinguished career was followed by nearly 20 years' busy and happy life in retirement. His work for the improvement of Indian agriculture will long survive him. *Requiescat in pace.*

Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, K.B.E., Vice-Chairman, Imperial Council of Agricultural Research, has been granted leave out of India for 2 months, with effect from the 18th October 1934, with permission to prefix to his leave the Dushera holiday on the 17th October 1934. The leave will be on full average pay for the first 8 days and on medical certificate on half average pay for the remaining period.

Mr. B. C. BURT, C.I.E., M.B.E., B.Sc., I.A.S., Agricultural Expert, Imperial Council of Agricultural Research, has been placed in charge of the duties of Vice-Chairman of the Council in addition to his own duties as Agricultural Expert during the absence of Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., on leave.

Mr. A. K. ADHIKARI, Extra Assistant Conservator of Forests (Assam), whose term of office as a member of the Indian Lac Cess Committee expired on the 31st July 1934, under rule 4 of the Indian Lac Cess Rules, has been re-appointed on the nomination of the Government of Assam, to be a member of the Indian Lac Cess Committee, with effect from the 1st August 1934, to represent the lac cultivators' interests in Assam.

Imperial Institute of Agricultural Research

Dr. HEM SINGH PRUTHI, Ph.D. (Cantab.), M.Sc., Assistant Superintendent, Zoological Survey of India, has been appointed Imperial Entomologist, Imperial Institute of Agricultural Research, with effect from the 5th September 1934.

Madras

Mr. PERCIVAL VENKATARAMAYYA, M.A., B.Sc. (Edin.), Assistant Agricultural Chemist, Coimbatore, has been appointed to officiate as Agricultural Chemist, Coimbatore, with effect from the date of taking charge from Rao Bahadur B. Viswanath.

Mr. D. G. MUNRO, B.Sc. (Aberdeen), Deputy Director of Agriculture, VIII Circle, Coimbatore, has been granted leave on average pay for eight months from 3rd January 1935, and on half average pay for fifteen days in continuation thereof.

Mr. K. S. VISWANATHA AYYAR, B.A., Assistant Agricultural Chemist, Coimbatore, has been granted a further extension of leave on half average pay for three months from 14th October 1934.

Dr. J. S. PATEL, M.Sc., Ph.D., Oilseeds Specialist, Coimbatore, has been recalled from leave. His return to duty will be compulsory.

Mr. M. PONNAYYA, G.M.V.C., will continue to be District Veterinary Officer, Vellore, until further orders.

Bengal

Dr. G. P. HECTOR, M.A., D.Sc., I.A.S., Director of Agriculture, Bengal, has been granted an extension of leave on half average pay for eleven months and twenty-nine days, with effect from the 21st October 1934.

Mr. M. CARBERY, M.A., B.Sc., M.C., I.A.S., Officiating Assistant Director of Agriculture and Agricultural Chemist, Bengal, has been allowed leave for one year, *viz.*, leave on average pay for seven months and nineteen days, with effect from the 24th October 1934, and leave on half average pay for the remaining period.

Mr. SURENDRA CHANDRA RAKSHIT, Laboratory Assistant under the Agricultural Chemist to the Government of Bengal, has been appointed to act as Assistant Agricultural Chemist during the absence on leave of Mr. Carbery or until further orders.

Mr. DEBENDRA KUMAR SEN, G.B.V.C., Lecturer, Bengal Veterinary College, has been allowed leave for three months, *viz.*, leave on average pay for twenty-two days, with effect from 1st November 1934, and leave on half average pay for the remaining period.

Mr. SATYA CHARAN MUKHERJI, Assistant Lecturer, Bengal Veterinary College, has been appointed to act as Lecturer of that College, during the absence on leave of Mr. Debendra Kumar Sen, or until further orders.

Mr. KUMUD CHANDRA SEN, G.B.V.C., Officiating Lecturer, Bengal Veterinary College, has been confirmed in that appointment, with effect from 12th August 1929.

Mr. SAILENDRA NATH SINHA, G.B.V.C., Hospital Surgeon, Bengal Veterinary College, has been appointed to the Bengal Lower Veterinary Service as Lecturer, Bengal Veterinary College, on probation.

Mr. HARI CHARAN GANGULI, G.B.V.C., Laboratory Assistant, Bengal Veterinary College, has been appointed to the Bengal Lower Veterinary Service as Lecturer, Bengal Veterinary College, on probation.

Mr. SERAJUL HAQUE, Inspector, Civil Veterinary Department, has been appointed to the Bengal Lower Veterinary Service as Lecturer, Bengal Veterinary College, on probation, *vice* Mr. Girindra Nath Chatterji, retired.

Mr. MOKSHADA PRASAD GHOSH, Inspector, Civil Veterinary Department, has been appointed to the Bengal Lower Veterinary Service as Assistant Director, Civil Veterinary Department, Eastern Range, Dacca, on probation.

Mr. ABDUL LATIF, Veterinary Assistant Surgeon, has been appointed to act as Lecturer, Bengal Veterinary College, in the Bengal Lower Veterinary Service, *vice* Lieut. S. C. A. DATTA, appointed to act as temporary Veterinary Research Officer, Muktesar.

United Provinces

Mr. C. MAYA DAS, M.A., B.Sc. (Edin), I A.S., on return from leave has been appointed to be Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur.

Dr. S. B. SINGH, M.Sc., Ph.D., temporary Deputy Director of Agriculture, North-Eastern Circle, on relief by Mr. C. Maya Das, has been reverted as Assistant Deputy Director of Agriculture, North-Eastern Circle, with head quarters at Bahraich.

Mr. W. HEAD, Deputy Director of Gardens, United Provinces, Saharanpur, has been granted leave on average pay for 8 months, combined with leave on half average pay for 4 months, with effect from 16th September 1934, or date of relief.

Mr. R. D. FORDHAM, Superintendent, Government Gardens, Agra, has been appointed to be Officiating Deputy Director of Gardens, United Provinces, *vice* Mr. W Head, granted leave.

Mr. J. G. BURNS, Garden Overseer, Kumaun, has been appointed to be Officiating Superintendent, Government Gardens, *vice* Mr. R. D. Fordham appointed Officiating Deputy Director of Gardens, but to remain attached to the Kumaun Gardens.

Punjab

Sardar Sahib Sardar KHARAK SINGH, M.A., I.A.S., Deputy Director of Agriculture, Montgomery, has been granted leave on average pay for three months and seventeen days and in continuation leave on half average pay for one year, ten months and 12 days, with effect from the 25th September 1934 preparatory to retirement.

Khan Sahib AGHA YUSAF ALI KHAN, Extra Assistant Director of Agriculture, Multan, has been appointed incharge of the duties of Deputy Director of Agriculture, Montgomery, with effect from the 25th September 1934, in a temporary post created for the purpose and relieving Sardar Sahib S. Kharak Singh, granted leave.

On the expiry of the leave granted to him Mr. A. HARDIE, Superintendent, Lawrence Gardens, Lahore, retired from Government service, with effect from the 29th August 1934.

Mr. E. A. HUGHES, Superintendent, Archæological Gardens, Lahore, and in addition officiating as Superintendent, Lawrence Gardens, Lahore, has been appointed Superintendent, Government Gardens, Lahore, with effect from the 29th August 1934, against a new post sanctioned in place of the two posts of Superintendent, Lawrence Gardens, Lahore, and Superintendent, Archæological Gardens, Lahore.

Bihar and Orissa

Mr. BHUT NATH SARKAR, L.Ag., Assistant Director of Agriculture, has been appointed to hold charge of the South Bihar Range until further orders, *vice* Mr. D. R. Sethi, appointed Director of Agriculture, Bihar and Orissa.

Mr. B. M. CHATTERJI, B.A. (Cal.), M.Sc.A. (Cornell.), Assistant Director of Agriculture in charge Chota Nagpur Range, has been granted leave for one year, *viz.*, leave on average pay for four months and on half average pay for the remaining period with effect from date of Lt.-Col. C. A. MacLean, Deputy Director of Agriculture, resuming charge of the Range.

On his return from leave, Lt.-Col. C. A. MACLEAN, M.B.E., M.C., M.A., B.Sc., I.A.S., Deputy Director of Agriculture, has been re-posted to the Chota Nagpur Range.

Central Provinces

On return from leave Mr. N. G. SULE has been re-appointed to officiate in the Central Provinces Agricultural Service, Class II, as Extra-Assistant Director of Agriculture, with effect from the 5th September 1934, and posted to Amraoti.

On relief by Mr. N. G. SULE, Mr. G. M. JOSHI, L.Ag., Officiating Extra-Assistant Director of Agriculture, Amraoti, in the Central Provinces Agricultural Service, Class II, reverts to his substantive post in the Subordinate Agricultural Service.

Mr. G. V. BAPAT, L.Ag., Agricultural Assistant, in the upper division of the Subordinate Agricultural Service (Field Staff), has been appointed to officiate in the Central Provinces Agricultural Service, Class II, as Extra-Assistant Director of Agriculture, Chhindwara, *vice* Mr. Laxmi Narayen Dubey on leave, or until further orders.

Mr. J. S. GURJAR, Officiating Extra-Assistant Director of Agriculture, Akola, in the Central Provinces Agricultural Service, Class II, has been appointed to hold the temporary post of Marketing Officer.

Mr. N. S. GANGAKHEDKAR, Officiating Extra-Assistant Director of Agriculture, Hoshangabad, has been posted to Akola, in the same capacity, *vice* Mr. J. S. Gurjar.

On return from leave, Mr. C. N. SUBANNAH has been re-posted as Assistant Director of Veterinary Services, Chhattisgarh division.

On relief by Mr. C. N. SUBANNAH, Mr. M. Y. MANGRULKAR, Officiating Assistant Director of Veterinary Services, Chhattisgarh division, has been transferred in the same capacity to the Jubbulpore division.

On relief by Mr M. Y. MANGRULKAR, Mr. RAHIM BUX, Assistant Director of Veterinary Services, Jubbulpore division, has been granted leave on average pay for four months.

Assam

Mr. S. MAJID, B.Sc., has been appointed on probation as Economic Botanist for the Deep Water Paddy Farm at Habiganj, with effect from the 1st September 1934.

REVIEW

"Rafiq-ul-Mawashi". By A. C. AGGARWALA. (Published by Messrs. Gulab Chand Kapur, Lahore. Price As. 12.)

We have received for review a copy of the book entitled 'Rafiq-ul-Mawashi', by Mr. A. C. Aggarwala, Professor of Hygiene and Dietetics, Animal Husbandry, Milk and Meat Inspection, Punjab Veterinary College, Lahore. The book is divided into 21 chapters under the following headings:—

"Importance of cattle in India", "Cows", "Important breeds", "Breeding", "Bulls", "Management of cows in pregnancy and at calving", "Judging the age of cattle", "Miserable condition of cattle", "Points to be noted in the purchase of cattle", "Castration", "Hygiene", "Housing arrangement", "A farmer boy's address to a bull", "Cattle feeds", "Weighing of live-cattle", "Our duty towards cattle", "Milking", "Milk and public health", "How to administer medicine", "Kindness towards cattle", "Some diseases of cattle and their treatment".

Written in Urdu by a specialist on the subject, publications of this kind should prove of considerable value in assisting breeders and dairymen to adopt modern methods in the care and management of their cattle and inexpensive publications in other important Indian languages would be welcome. The publishers are Messrs. Gulab Chand Kapur, Lahore, and the price of the publication is As. 12. (A. O.).

NEW BOOKS
On Agriculture and Allied Subjects

Economic Plants. By Ernest Elwood Stanford. (Century Biological Series.) Pp. XXIII + 571. (New York and London: D. Appleton Century Co., Inc., 1934.) 21*s*. net.

Trees of Trinidad and Tobago. By R. C. Marshall. Pp. III + 102 plates. (Trinidad: Government Printing Office, 1934.) 3*s*.

Arable Crops of the Farm. By J. R. Bond. (Ministry of Agriculture and Fisheries Bulletin No. 72.) Pp. V + 78. (London: H. M. Stationery Office, 1934.) 1*s*. 3*d*. net.

Taxonomy and Phylogeny of Monocotyledons. The Families of Flowering Plants. 2: *Monocotyledons arranged according to a New System based on their probable Phylogeny*. By J. Hutchinson. Pp. XIII + 243. (London: Macmillan and Co., Ltd., 1934.) 20*s*. net.

Report on Fungus, Bacterial and other Diseases of Crops in England and Wales, 1928-1932. (Ministry of Agriculture and Fisheries Bulletin No. 79.) Pp VI + 117 + 8 plates. (London: H. M. Stationery Office, 1934.) 2*s*. net.

Researches on Fungi: Vol. 6: The Biology and Taxonomy of Pilobolus, the Production and Liberation of Spores in the Discomycetes, and Pseudorhizæ and Gemmifers as organs of certain Hymenomycetes. By A. H. Reginald Buller. Pp. XII + 513. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1934.) 28*s*. net.

Tadstools and Mushrooms and other larger fungi of South Australia: Part I containing General Introduction and the Toadstools and Mushrooms. By J. B. Cleland. (Handbooks of the Flora and Fauna of South Australia. Issued by the British Science Guild, S. Australian Branch.) Pp. 178 + 6 plates. (Adelaide: Government Printer, 1934.) 5*s*.

A Textbook of Bacteriology. With a Section on Pathogenic Protozoa. By H. Zinsser and S. Bayne-Jones. Seventh edition, rewritten, revised and reset. Pp. XIX + 1226. (New York and London: D. Appleton Century Co., Inc., 1934.) 30*s*. net.

Insect Physiology. By V. B. Wigglesworth. (Methuen's Monographs on Biological Subjects.) Pp. X + 134. (London Methuen and Co., Ltd., 1934.) 3*s*. 6*d*. net.

Specifications and Methods of Analysis for Certain Insecticides and Fungicides. (Ministry of Agriculture and Fisheries Bulletin No. 79). Roy. 8vo. Pp. II + 10. (London: H M. Stationery Office, 1934.) 3*d*. net.

Biology for Everyman. By Sir J. A. Thomson. Edited by E. J. Holmyard. Vol. 1 Pp. X + 756. Vol. 2. Pp. VI + 757—1561. (London: J. M. Dent and Sons, Ltd., 1934.) 15*s*. net.

Our Garden Birds: their Food, Habits and Appearances By H. M. Batten. Pp. 192 + 39 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd.; T. C. and E. C. Jack, 1934.) 5*s*. net.

Brood Disease of Bees; being the Report of a Conference held at Rothamsted on May 19th, 1934, under the Chairmanship of Sir E. J. Russell with Contributions by Sir E. J. Russell, D. Morland, John Anderson, Miss A. D. Betts, L. Illingworth, C. H. Chalmers, H. L A Tarr and others. Pp. 46. (Harpenden: Rothamsted Experimental Station, 1934.) 1*s*. 6*d*.

A Manual of Biochemistry. By J. F. McClendon. Pp. VII+381. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1934.) 31*s*. net.

Fundamentals of Biochemistry: in relation to human physiology. By T. R. Parsons. Fourth edition. Pp. XII+435. (Cambridge: W Heffer and Sons, Ltd., London: Simpkin Marshall, Ltd., 1933.) 10*s*. 6*d*. net.

A Text-book of Quantitative Chemical Analysis. By A. C. Cumming and S. A. Kay. Sixth edition, revised by F. C. Guthrie and J. T. Nauce. Pp. XV+482. (London and Edinburgh: Gurney and Jackson, 1934.) 15*s*. net.

The Agricultural Evolution of a Yorkshire Village. By A. G. Ruston, and D. H. P. Witney. Pp. VII+459+12 plates (London: Edward Arnold and Co., 1934.) 25*s*. net.

Rural Britain Today and Tomorrow. By J. A. S. Watson. Pp. XXIII+161. (London and Edinburgh: Oliver and Boyd, 1934.) 5*s*. net.

Change in the Farm. By T. Hemel. Pp X+201. (Cambridge: At the University Press, 1934.) 10*s*. 6*d*. net.

Cotton: from the Raw Material to the Finished Product. By R. J. Peak. Revised and enlarged by H. P. Curtis. Fourth edition. Pp. 226. (London: Sir Isaac Pitman and Sons, Ltd., 1934.) 5*s*. net.

Poultry Ailments for Poultry-Keepers. By W. P. Blount Pp. 306. (London: The Poultry World, Ltd., 1934) 5*s*. net.

Poultry Farming in the East. By Mrs. A. K. Faukes. Fifth edition. Revised and brought up-to-date. (Lucknow: The Lucknow Publishing House, 1933.) Rs. 4-8-0.

Veterinary Pathology and Bacteriology. By S. H Gaiger and G. O. Davies. Pp. VIII+610+190 illust. (London. Baillière, Tindall and Cox, 1934.) 25*s*. net

Hoare's Veterinary Materia Medica and Therapeutics. Edited and largely re-written by J. Russell Greig. Pp. X+520. (London· Baillière, Tindall and Cox, 1934.) 21*s*. net.

Veterinary Helminthology and Entomology. By H. O. Monnig, B.A., Dr. Phill., B.V.Sc. Pp. XVI+404+264 illust. (London: Baillière, Tindall and Cox, 1934.) 30*s*. net.

Brucella Infections in Animals and Man. Methods of Laboratory Diagnosis. By I. Forest Huddelson, Pp. XIV+108+24 figs. (12 colour.) (New York: The Commonwealth Fund, 1934.) $2·25.

Coccidia and Coccidiosis of Domesticated, Game and Laboratory Animals and of Man. By Elery R. Becker. Pp. 147+25 figs. (Iowa: Collegiate Press, Inc. Ames., 1934.) $2·50.

Notes on Mating Stallions and Mares. By Capt. Oscar Greig. (Devon: W. Shobrooke, Moretonhampstead.) 1*s*. 3*d*.

APPENDIX

Instructions to Authors of Publications of the Imperial Council of Agricultural Research*

1. All manuscripts should be clean, clear and carefully revised. Only one side of the paper should be used, and as far as practicable the original type-written copy and not a carbon copy should be sent. Capitals should be sparingly used, and all the necessary punctuations should be done in the MS. and not left for introduction in proofs.

2. The title of a paper should not be lengthy.

3. It is desirable that MS. should have suitable heads and sub-heads. In numbering the principal divisions of a paper roman numerals should be used. The use of arabic figures and (*a*), (*b*), (*c*), etc., is genreally reserved for numbering the sub-divisions coming under each head.

4. Articles submitted for publication either in the *Indian Journal of Agricultural Science* or in the *Indian Journal of Veterinary Science and Animal Husbandry* should be accompanied by abstracts for publication in *Agriculture and Live-stock in India*. Abstracts should be concise, but should be long enough to explain the matter dealt with; ordinarily no abstract should exceed 200 words.

5. When a word or line is intended to be printed in *italics* it should be underlined with a single line, in SM. CAP. with two lines, in CAPITALS with three lines, and when in **Antique** (heavy type) with a wavy line (..........).

6. In descriptive matter, numbers under 100 and all numbers occurring at the beginning of a sentence should be in words.

7. Local names for crops, technical operations, etc., should be defined where they first occur in the text, *e.g.*, *rabi* (spring crop). The use of local weights and measures should be avoided as far as possible. Vernacular names, such as *jowar, bajri,* should be in italics without a capital letter, and each such name where it first occurs should be followed by its scientific equivalent in brackets, *e.g.*, *jowar* (*Andropogon Sorghum*). It is usual to write the initial letters of varietal names in capitals, *e.g.*, Striped Mauritius, Dharwar-American cotton and Broach cotton.

8. Botanical and zoological names are printed in italics and should be underlined in the MS., *e.g.*, *Triticum vulgare* L.; *Diplodia Corchori* Syd.; *Pyrilla aberrans* Kirby. The International Rules of Botanical Nomenclature and the International Rules of Zoological Nomenclature should be followed. The names of chemical substances should not be written with a capital letter; they are printed in roman type (*e.g.*, calcium carbonate, prussic acid).

9. The following and similar abbreviations may be used freely:—*viz.*, *e.g.*, *i.e.*, mm. (millimetre), cm. (centimetre), grm. (gramme), mg. (milligramme),

* Spare copies of these Instructions can be had on application to the Secretary, Imperial Council of Agricultural Research (Publication Section), New Delhi.

c.c. (cubic centimetre), sp. gr. (specific gravity), lb. (pound), cwt. (hundredweight), in. (inch), ft. (foot), oz. (ounce), md. (maund), sr. (seer), ch. (chattack). Other abbreviations should be used sparingly, if at all.

10. References to plates should be given within brackets, without prefixing the word "see" or "cf.", in the MS. itself, and should not be left over for introduction in proofs. For example, "The parasite (Pl. X, fig. 4) was present late in 1906".

11. The word "Table" is preferable to "Statement", and tables should be numbered consecutively in roman figures. Each table should have an explanation as a sub-head. It is more convenient for reference if tables can be printed horizontally; for this purpose they should not exceed in width the printing measure of the page (5"). *Example*—

TABLE IV.

Results of water-saving experiments on wheat (Pusa 12) at Gungapur, Haripur and Sargodha, 1916-17.

Station	No. of irrigations including the preliminary watering	Yield per acre in maunds and seers				Average yield per acre			
		Grain		Straw		Grain		Straw	
		Mds.	Srs.	Mds.	Srs.	Mds.	Srs.	Mds.	Srs.
Gungagur	One	12	19½	20	10	9	34	21	17
Haripur	„	8	31	19	14				
Sargodha	„	8	12½	25	27½				

12. References to literature, arranged alphabetically according to author's names, should be placed at the end of the article, the various references to each author being arranged chronologically. Each reference should contain the name of the author (with initials), the year of publication, the abbreviated title of the publication, volume and page. In the text the reference should be indicated by the author's name followed by the year of publication enclosed in brackets; when the author's name occurs in the text, the year of publication only need be given in brackets. If reference is made to several articles published by one author in a single year, these should be numbered in sequence and

the number quoted after the year both in the text and in the collected references. This system of referencing is the same as is used in the *Biochemical Journal* with slight modification and will be clear from the following illustration:—

The work of Osborne and Mendel [1919, 1, 2] and Steenbock and Boutwell [1919] had indicated an association of the fat-soluble vitamin with the green parts of plants. This view was examined by Coward and Drummond [1921] who reported that vitamin A was not synthesised by etiolated shoots but that green leaves were active in its formation. Another worker [Wilson, 1922], on the other hand, found that etiolated shoots if given in sufficient quantity could supply the fat-soluble vitamin and that this factor was therefore formed in the absence of light.

REFERENCES

Coward, K. H. and Drummond, J. C. (1921). *Biochem. J.* **15**, 530.
Osborne, T. B. and Mendel, L. B. (1919, 1). *J. Biol. Chem.* **37**, 187.
——————————— (1919, 2). *J. Biol. Chem.* **41**, 549.
Steenbock, H. and Boutwell, R. (1919). *J. Biol. Chem.* **41**, 149.
Wilson, J. (1922). *J. Biol. Chem.* **51**, 455.

Abbreviations, as far as possible, should follow the system adopted in "A World List of Scientific Periodicals" published by the Oxford University Press.

13. Papers should be complete when submitted for publication. As alterations and additions at the proof stage cause both additional expense and delay, they should be resorted to as little as possible. In making corrections in proofs the recognized symbols which will be found in the "Standard Dictionary" should be used. Second (page) proofs will be submitted to authors who should return them promptly.

Illustrations.

14. As the *format* of the journals has been standardized, the size adopted being crown quarto (about $7\frac{1}{8}'' \times 9\frac{5}{8}''$ cut), no text-figure, when printed, should exceed $4\frac{1}{2} \times 5$ inches. Figures for ~~plates~~ should be so planned as to fill a crown quarto plate—the maximum space available for figures being $5\frac{3}{4} \times 8$ inches exclusive of that for letterpress printing.

15. Photos or drawings for illustration should accompany the manuscript and each should bear on the reverse side the name of the paper to which it relates together with the title or legend, figure or plate number, and the size to be reproduced. When giving instructions for reduction linear measurements are understood; thus, "half-size" means reduce to half the length and breadth, not half the area. A photograph should not be rolled up, nor pinned, and should always be packed flat. A complete list of plates and figures should always accompany the paper.

16. Line drawings should be made with clear black lines on smooth white paper, preferably Bristol board. Rough paper should be avoided. Care should be taken that all the lines are drawn firmly; scratchy or grey lines, produced by

the ink being thinned down, are not permissible. Drawings should be larger than the required size. All lettering should be neatly and clearly put in, care being taken to make all lettering sufficiently large to stand reduction.

17. For half-tone work, copy should be made on glossy silver paper and of the same size or larger than the size required.

18. For three-colour work, copy may be oil-painting, water-colour, coloured photograph or coloured transparency, and larger than the size required. In preparing copy, one should use only the primary colours, in any combination, as only inks of primary colours are used in printing. Originals can be enlarged, if necessary, but this should be avoided if possible.

19. For detailed instructions regarding preparation of illustrations, it would be of advantage to refer to Mr. C. M Hutchinson's article on "Photographic illustrations" in the *Agricultural Journal of India,* Vol. XI, Pt. 3, July 1916, and Mr. A. W. Slater's paper on "The Preparation and Reproduction of Scientific Illustrations" in the *Proceedings of the Third Entomological Meeting*, 1919, which has been reprinted as *Bulletin No. 114 of the Agricultural Research Institute*, *Pusa*.

NOTICE

A limited number of copies of the undermentioned publications of the Imperial Department of Agriculture in India are available for free distribution, provided the cost of packing and postage or railway freight is met by the indentor. Applications should reach the Secretary, Imperial Council of Agricultural Research (Publication Section), Imperial Record Department Building, New Delhi, on or before 31st March 1935.

1. Bulletin of the Imperial Institute of Agricultural Research, Pusa, No. 15—Note on the Extension of Cultivation of Fibre Plants in India.

2. Report on the Progress of Agriculture in India for the years 1907-09, 1909-10, 1911-12 to 1918-19.

GIPD—L 355 IC of AR—6-2-35—1,000.

ORIGINAL ARTICLES

INDIAN AGRICULTURE AND PLANT BREEDING*

BY

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The improvement of the produce of the soil and the consequent improvement in the conditions of rural life in India is the objective of every agricultural department in India. In the various departments of agriculture, workers in all branches of agricultural science—chemists, plant pathologists, entomologists, bacteriologists, botanists, and agriculturists—have each contributed to the mass of knowledge which we possess to-day, and we are only just realizing that, if we are to exploit to the fullest economic advantage the results of scientific investigations in agriculture, we must add to the work of these specialists the labours of officers concerned with the investigations of marketing —the organization of production and exchange.

It is impossible within the limits of a Presidential address to attempt a survey of all the work which has been done in India for the improvement of the produce of the soil. In its widest aspect this would include a survey of the cattle problem and of the Indian dairy industry—for cattle and milk are almost as much as the produce of the soil as a crop of grain. I propose in this address to deal only with improvements in Indian crops which have resulted or may result from the work of the plant breeder. Some years ago this Congress had the privilege of hearing a very able address on this subject from the late Mrs. Gabrielle Howard who gave us a broad general survey of the principles of plant breeding. To-day I shall indicate some of the major problems which are engaging the attention of the plant breeder in India and which are likely to yield results of economic importance.

The work of the plant breeder has for its object the improvement of agricultural produce either in quality or yield. At the present time when prices of agricultural produce are low the improvement of the quality of agricultural produce offers a more promising field of research, in the economic sense, than the production of high yielding varieties. It is, however, not possible to draw a sharp line of demarcation between these two goals of the plant breeder.

Improvement in the quality of a crop may result from the production of a type which is resistant to disease and the reduction of the loss due to disease will inevitably be reflected in increased yields. Again the labours of the breeder may result

*Presidential Address to the Agricultural Section of the Indian Science Congress, Calcutta, Jan. 1935.

in the evolution of types which possess a shorter life cycle than that of the established variety; such a property will produce, in the case of a North India *rabi* crop, an extension of the area of the crop towards the South, where an earlier hot weather necessitates an earlier harvest, and consequently increased production. It is evident therefore that the present economic depression militates heavily against the chances of the plant breeder producing results of immediate economic significance. Notwithstanding this, however, steady progress has been achieved in India both as regards results of immediate importance and in laying the foundation for future developments for more prosperous times.

A field of work which has, until quite recently, been relatively neglected in India is the breeding of varieties resistant to disease. Varieties which possess various economic advantages in yield and quality and which also are said to possess disease resistance have been bred in considerable numbers, but the deliberate direction of a plant breeding investigation towards the production of a disease resistant type has in India been very rare. At Pusa recently we have succeeded in producing types of *rahar* (pigeon pea, *Cajanus indicus*) which are resistant to the wilt disease caused by *Fusarium*. These results have been published and further work, not yet published, has been carried out on the inheritance of the property of resistance to wilt.

We were fortunate to find among the 82 different types which make up the mixed country crop of *rahar* some types which were resistant and some which were extremely susceptible to the disease. A cross between a susceptible and resistant type has indicated that resistance depends upon the presence of probably at least three pairs of factors and has yielded the somewhat surprising result that none of the factors for resistance is linked to factors which are responsible for the inheritance of the more important morphological characters of the types. We have succeeded in producing hybrid *rahars* which are resistant to wilt disease but which possess the morphological characters of the type which is susceptible to disease. This is a point of practical importance as it means that it should be possible in this crop to combine any desirable morphological character with the property of resistance.

There is perhaps no crop in India with which the labours of the plant breeder have been so successful as with wheat. The striking success of the Pusa wheats bred by the Howards will be familiar to all of you. There is also perhaps no crop in India which sustain such heavy and consistent loss from disease as wheat does from rust. The efforts of plant breeders in India up to now have generally been directed towards producing heavy yielding varieties of good grain quality and such rust resistance as these varieties possess has been the result of good fortune rather than deliberate intention on the part of the investigator. Recent investigations in India upon the parasites which cause this disease have suggested that India is fortunate in possessing a relatively small number of different races of these parasites and that their persistence from one wheat growing season to another takes place in the hills. This advance in our knowledge of the cause of the disease

makes it possible to design a comprehensive scheme for the breeding of rust resistant wheats and this work is now being undertaken by the Imperial Department of Agriculture. The research will involve the testing for rust resistance of the established and important types of wheat grown in India and their crossing with various foreign varieties which possess the resistant property. The investigation is, of course, complicated by the fact that there is more than one strain of the parasite and that a variety of wheat may be bred resistant to one strain and susceptible to others. I shall not say more about this interesting subject as we shall have ample opportunity for discussing it in our symposium on cereal rusts.

Recent progress in wheat breeding in India has resulted in the production of races of wheat of high grain quality. The results of milling and baking tests carried out in the United Kingdom with Pusa wheats have shown that in a new type, Pusa 111, India possesses a wheat which is from the bread making point of view equal in quality to the best Manitoba wheat. Another new wheat, Pusa 114, is almost equal to Pusa 111 in quality and has the added advantage that it has proved disease resistant both in northern India and in Sind.

Oil seeds are a crop of great importance in Indian agriculture, and as a result of the Ottawa Trade Agreement Indian vegetable oils and oil seeds now enjoy substantial tariff preferences in the United Kingdom. To exploit fully the advantages of these tariffs, work on the improvement of oil seeds is essential and is in progress at various centres in India Linseed is one of the oil seeds on which extensive investigations have been made with the object of producing a white or yellow seed of high oil content and good yielding power. White or yellow colour in the seed is preferred to brown as the lighter coloured seeds yield a white oil. Generally speaking it is believed that high oil content is associated with large size in the seed and because of this belief 'bold' seed commands a higher price than small seeded types. The types of linseed, however, which grow and yield well in Gangetic India are the small seeded types, and, with the object of producing a large seeded type capable of good yield in the Gangetic alluvium, crossing has been carried out between small seeded types which grow well in Northern India and 'bold' seeded types which grow well in peninsular India. Numerous hybrids have been produced of high oil content and medium seed size. The work of selecting for such a character as oil content presents difficulties, as oil content is not perceptible to the eye and can only be judged by chemical analysis. It was therefore necessary to base the selection from hybrid populations on other desirable characters, such as growing power and tillering capacity, and to hope that among selections made on this basis we should find some of high oil content. A slight guide to oil content was the observation that large size in the seed was generally accompanied by large size in the flower.

While the main object of the genetical research on linseed at Pusa has been economic, the work has yielded results of considerable scientific interest and the full

scheme of inheritance of colour in the petal, style and seed has been worked out and published. Colour in the petal is due to the interaction of several factors and a type which is new to Indian linseed is a double recessive form with pink flowers produced by crossing among the Pusa types. By crossing this pink form with other types we hope to obtain a recessive which will lack all the known factors for colour in the petal, and which, since seed colour, is linked with petal colour, may offer economic possibilities in the production of a suitable seed for oil. This is a typical example of the manner in which the purely scientific aspects of a genetical study may suddenly reveal an avenue for economic improvement.

The potato differs from most of the main field crops in that it is propagated vegetatively by means of tubers. A valuable plant can be propagated true to type, no matter how heterozygous it may be. Coupled with this advantage, however, is the disadvantage that many diseases can be transmitted by tubers and the control of disease is more difficult than in the case of seed-propagated plants.

The present situation of potato growing is unsatisfactory. All the potatoes in general cultivation outside South America appear to have been derived from one or two varieties that were introduced into Europe in the 16th century. The number of varieties was increased by selection from seedlings and by crossing but with such poverty of initial breeding material it is hardly surprising that little real progress has been made. The problems of blight (*Phytophthora infestans*), virus diseases, etc., remain unsolved and, in fact, a *cul de sac* was reached. But with the discovery by the Russian Expedition to South America—and the succeeding American and German Expeditions—of a large number of both wild and cultivated species, some of them possessing characters exceedingly valuable from the breeding view-point, the outlook has changed entirely and it is now possible to take a more hopeful view of the future of potato growing.

In India the problem is peculiarly complicated. In the plains during the hot weather the grower loses the greater part of his stock owing to rotting caused by various fungi and bacteria ; no really satisfactory method of storage, which is at the same time commercially practicable, has yet been evolved. And even more serious difficulty is that after two or three seasons in the plains potato varieties appear to 'degenerate'—doubtless largely due to the virus diseases which are so common in the potato—and the cultivator has to obtain a fresh seed supply from the hills, paying heavy freight on this. In the hills the crop is liable to blight from which the crop in the plains is fortunately generally free. Again in those parts where two crops in the year are taken the tubers from the one crop cannot be used as seed for the other, unless there is an interval of about two months, as the potato tuber exhibits dormancy.

It will be clear from the above that there are many difficulties to be surmounted in effecting potato improvement in India. Up to now almost nothing has been done

in this direction, practically all the previous work on this crop having been limited. to storage problems. Recently, however, a comprehensive scheme of research and breeding at Pusa and at a sub-station in the hills, with the aid of a grant from the Imperial Council of Agricultural Research, has been drawn up. This embraces : (1) The study and classification of the varieties usually grown in India ; (2) The procuring of South American potato material and the crossing of this with the best Indian varieties in order to produce new varieties possessing desirable qualities, such as immunity or high resistance to blight, resistance to virus diseases, etc. ; (3) The study of the factors influencing flowering and fruit development, for it is well known that fruit formation and seed-setting in the potato is usually poor—a knowledge of this and allied problems is necessary for successful hybridization ; (4) The possibility of breaking dormancy in the tuber by simple chemical or mechanical treatments has also to be investigated.

No account of modern progress in plant breeding in India could be complete without a mention of the achievements of the plant breeder in the improvement of the sugarcane. Sugarcane like potato is a crop which is vegetatively propagated and in this sense offers a relatively easy problem to the plant breeder with the accompanying disadvantage of the ready perpetuation of disease in the so-called 'seed'. The advantage lies in the fact of course that a desirable hybrid can be readily propagated without being fixed in the Mendelian sense. Six years ago this Congress had an able exposition of this subject from Rao Bahadur Venkatraman in his presidential address. Since that date while progress in the economic sense by increasing the area under improved varieties has continued on an increased scale the most interesting work from the point of view of a Science Congress has been the intergeneric hybrids produced at Coimbatore by crossing sugarcane with sorghum. It is at present too early to say definitely whether these new hybrids will have economic importance ; one of them Co. 352 appears very promising under Coimbatore conditions, ripening in 6-7 months and maintaining its juice for another 3 months. The recently established cytological laboratory at Coimbatore will undoubtedly find interesting material in this intergeneric cross.

This leads me directly to what has been up to now the most serious gap in our genetical and plant breeding research in India. I refer to the lack of cytological investigation upon the material with which plant breeding research has been carried out. The physical mechanism of heredity lies in the cell and its chromosomes, and a wealth of material awaits the investigator who can study the numerous crops which have been and are now the subject of genetical research in India. The central agricultural research station, now at Pusa and soon to be at Delhi, is shortly adding a cytological section to its numerous activities, but there is a large field of work and while plant breeding owing to the years of time and the area of land which it requires is difficult to prosecute in many Indian universities, the cytological side of genetical research is one in which we may hope for fruitful results from co-operation within the universities.

There is one aspect of the plant breeders' work which we, who labour for agricultural improvement in India, should not lose sight of. We, who are botanists, may produce a heavier yielding variety of a crop, but there is a limit to the productivity of the soil as it is generally cultivated by the ryot, and therefore improved methods of cultivation must accompany the introduction of improved varieties if we are to maintain the fertility of our lands. The labours of all of us in all our respective branches of science are equally important in the advancement of the oldest and most important industry in India.

THE NUTRITION OF INDIAN CATTLE, PART II.

MALNUTRITION IN RELATION TO HEALTH AND PRODUCTION CAPACITY OF ANIMALS

BY

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In a previous publication on this subject [Sen, 1933], a short review has been given of our knowledge of the role of nutritional factors in relation to cattle breeding problems with special reference to Indian conditions. The object of the present paper is to study the effect of malnutrition on the health and disease-susceptibility of animals, and to discuss briefly the position of our animal industry from this standpoint. Attention will be directed not to the effect of starvation or gross under-nutrition on the health and disease of cattle but to the results of the shortage of certain particular nutrients in an otherwise sufficient ration. There is no doubt that in this country gross under-nutrition or starvation has brought about degeneration of Indian cattle on a large scale and has made them economically unproductive. This condition is most likely to be apparent in village herds where a sufficient amount of food is seldom available. There are however other instances where, though the amount of feed is sufficient, the quality may not be up to the required standard and the ration is unsuitable for supporting the growth of the animals or their productive capacity. Cases of this type are very common, specially where an intensive system of dairying is conducted, and deserve our urgent attention.

In studying the question of malnutrition we propose to consider the effect of deficiencies under separate sections, examining briefly the evidence of lack of some particular substances in the feed and we may begin by stating the fundamental facts that for the proper requirement of animal growth, maintenance and production, certain substances are necessary, namely a minimum amount of digestible protein, a sufficient amount of energy, usually reckoned in terms of calories (heat units), which is mostly supplied by the starchy and fatty components of the diet, water, minerals and vitamins. Apart from these chemically and physiologically active substances, certain other conditions have to be observed by the successful farmer, namely, provision of sufficient dry matter in the ration, inclusion of succulent and appetizing food and other similar details, but with these we are not concerned in this article.

It is unfortunate that though we have in this country an unusually large number of cattle of various types and have also in recent years started breeding improved types with or without foreign blood, no systematic attempt has been made to find out if these improved breeds can be supported satisfactorily

by the rations ordinarily fed in this country. There is no doubt that the deterioration seen in most of our indigenous breeds is due to a number of causes, of which malnutrition and disease are probably the most important, and which are to a large measure interdependent. Though this relation between malnutrition and degeneration in cattle is generally known, very little record of experimental work on the subject can be found in the literature dealing with Indian conditions. Most of the information on this subject is obtainable only in foreign publications dealing with cattle of other countries and how far these results are applicable to the conditions pertaining to this country is not known Probably they are more applicable to highly productive local breeds and to cross-breds with foreign blood than to the ordinary, already emaciated village cattle Since to a great extent indigenous animals appear to have adapted themselves to the type of food stuffs available in this country, namely to a diet containing a low amount of protein and minerals and a fairly high amount of fibre, the net consequence of this malnutrition has been the survival of a type of animal which is small and undeveloped and is economically very unproductive. The milk yield of the cows is low ; breeding difficulties are common and in the case of draught animals, the return in terms of work is very small. Large numbers of such animals exist throughout India and are from an economic standpoint a serious loss to the country. Any attempt to improve the animal industries of India must therefore take into account the need for adequate and well-balanced diets for domesticated animals of all kinds, and in order to study what constitutes a well-balanced diet, systematic research work on the nature of our food-stuffs is essential. Bearing these facts in mind, I shall now deal with the subject of malnutrition as observed in indigenous animals. The illustrations of cases which will be found in this paper are mostly taken either from our own experimental work at Muktesar or from instances which have come under our observation in the field.

I.—The protein problem

It is common knowledge that a minimum amount of digestible protein has to be supplied daily in the ration for the mere maintenance of an animal and that the biological value of this protein should be high, but even the adopted standards in western countries differ from one another to a certain extent and comparatively little research has so far been possible in this country to fix standards suitable for Indian animals and the Indian climate and conditions. The main source of protein is the concentrate or grain mixture, although the roughage also contributes a certain fraction. There are however certain classes of fodder, such as alfalfa, lucerne, clover, e c., which have a high protein content and under certain conditions can supply the major part of the protein need of the body. Normally in many parts of this country several kinds of straw and hay, such as rice straw, *jowar* straw, wheat straw and hay made from some common grasses form the main part of the bulky ration. These fodders are very poor in protein and animals

which are chiefly dependent on them are bound to suffer from protein shortage and our observations show that this does occur when a small amount of cake is the only supplement made to a straw ration, and the result of a chronic protein starvation is always reflected in the condition of the animals, namely, emaciation, partial sterility and stunted growth. The milk yield of cows so fed is also seriously affected especially in the case of imported breeds where protein deficiency may cause ill effects immediately. In well-managed dairies, if the concentrates are of good quality, there is usually no risk of protein shortage, because in deciding on the amount of concentrate, attention is always paid to the milk yield of the cow. Moreover, owing to the comparatively low cost of grain in India, it is often the case that slightly more protein than is necessary for maintenance and production is provided and there is no harm in this, provided a good nutritive ratio is maintained. The danger of protein insufficiency may however arise, even in well-controlled farms, from the fact that locally available concentrates and fodders may be of inferior quality and there is evidence that the grain and cake obtainable in different provinces are not of equal value in this respect owing to differences in the soil. Feeding trials are however the only method of determining the biological value of the concentrates obtained from different localities and there is a great need for such tests to be systematically carried out in every province in India.

II.—The mineral question

Next to protein, the most important problem is the question of mineral supply, not only in indigenous cattle but also in the case of mixed breeds. Various difficulties are experienced because of the lack of suitable minerals in the ration Indeed, we believe that the mineral question is even more important in this country than the protein question and a general outline of the necessity for adequate supplies of lime and phosphorus in the diet in relation to health and breeding operations of cattle was given in the previous paper. Here it will be sufficient to say that lack of lime or phosphorus or both leads to emaciation, pica, unthriftiness, stunted growth, sterility, low milk production or bone diseases in cattle. Our observations show that under laboratory conditions, the effect is much more pronounced in imported or half-bred cattle than in indigenous animals, though even in the latter the ill effects of a low mineral diet are always observable. Examples of this nature are shown. Plate VII, fig. 1 is the photograph of one of our dairy cows, Khairi 75, a half-bred Holstein-Hariana. She was a good milker, had already passed three lactations and was in calf when she was brought under the present experiment, where she was put on a phosphorus deficient diet, or more correctly, on a diet which had an abnormal lime/phosphorus ratio, with a slight protein deficiency for the first two months. Within a few months of the experiment the animal had lost much weight and gave birth to a calf which died in an hour's time. Plate VII, fig. 2 was taken at this time and the condition of the dam and the calf is readily seen. A highly unbalanced ration with low amount of phosphorus and a a slight deficiency of protein in the diet in fact led to a marked emaciation and the

birth of a non-viable calf. The condition of the animal became so bad after calving that she had to be returned to the normal dairy ration but did not improve for about a month and it was only when, in addition to the dairy ration, she was allowed to graze on very good pasture land containing plenty of green grass, that she rapidly regainded her original weight.

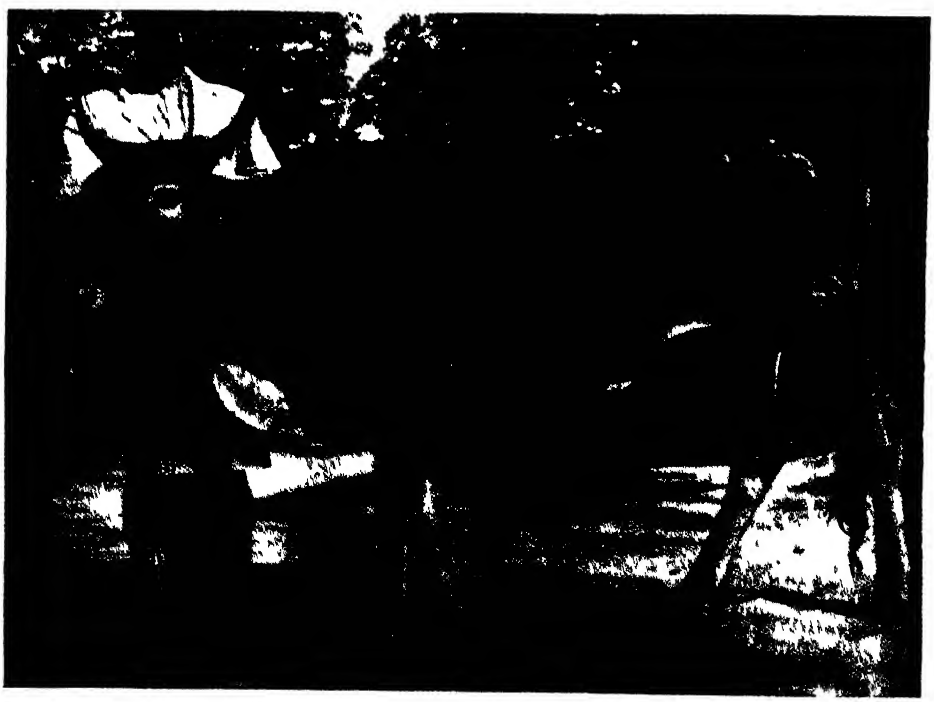
Similar results, (Plate VIII, fig. 1) have been observed in another animal, No. 203, under the same experimental conditions, whereas a control animal, on the same experimental diet with the addition of simple phosphate supplement, has maintained her body weight and general condition, thus showing that the ill effects in the case of the other two cows were due to the unbalanced nature of the ration.

Similar, though not striking, results have been obtained in lime deficiency experiments Thus Hansi 207, a Sahiwal cow of our dairy, was placed on a diet poor in lime and rich in phosphorus with a sufficient amount of protein. The animal started to lose condition gradually and became very unthrifty and dull after about five months. A second animal under this experiment, Phul 150, Holstein-Sahiwal has reacted to a greater extent and her condition is shown in Plate VIII, fig. 2.

The above results of laboratory experiments are so striking that it is necessary to consider if similar instances are to be observed under field conditions It is well known that in many parts of the country, the soil is poor in lime or phosphorus or both, and that this poverty of the soil is liable to be reflected in the composition of the pasture. In animals reared on such poor pasture, troubles due to malnutrition are to be expected and the existence of various diseases due to deficiency of lime or phosphorus in the feed are well-kown in various parts of Europe, America and South Africa, where most of the significant work has been done Literature in this country is very poor on this subject due, not to the non-existence of the ill-effects of malnutrition, but rather to the fact that few have tried to study the subject, or, when cases have come to their notice, have not placed their observations on record. It is well-known that deficiency of lime or phosphorus leads to certain types of bone disease and we have received reports of several such cases from South India recently. Equine osteoporosis, due to lack of lime in the diet, has long been known to occur quite frequently, and we have had cases of osteomalacia in cattle in a village, the fodder of which on analysis was found to be low in lime and very poor in phosphorus. Movement of the affected animals to an adjoining village where better pasture was available stopped the progress of the disease. The adjoining picture (Plate IX) obtained through the courtesy of the Director of the Civil Veterinary Department of His Exalted Highness the Nizam's Government, shows one of the affected animals in a Deccan village, in which the extremely emaciated condition may be noted. There were callus formations on some of the ribs, but these cannot be well seen in the picture.

Although a mineral deficiency must have been a factor in the degeneration of indigenous herds, an even more striking effect of such deficiency is observed when

Fig 1 Cow 203, cross bred, after several months on a low phosphorus diet



ase of osteomalacia in a Deccan village Note the emaciated condition Malformations on the ribs are not well seen in the photograph

heavy milking breeds of India, or imported or cross-bred animals are kept under observation, because the need of minerals in their case is comparatively greater. It is easy to calculate theoretically the need of a heavy milking cow for lime and phosphorus in terms of her maintenance requirements and for milk production, and in practice it is found that unless the pasture is very good addition of minerals must be made, but in India at present there is little exact knowledge as to what minerals are deficient in the fodder grown in different localities. In my previous paper a statement was made that milk fever, a common trouble in western countries, is rare in India. The information at our disposal at that time related chiefly to Madras and Bengal. Reports have since been received that this disease is not at all infrequent in the Punjab, and cases amongst Sahiwal cows have occurred in Bihar. Since this disease affects heavy milkers only, the incidence of this complication in the Punjab breeds can be well understood. It is fortunate that the pastures in most of the dry parts of the Punjab, from where the best breeds come, are fairly rich in lime and phosphorus, but the rapid increase in the canal-irrigated areas, in which the character of the soil is being changed, is likely to give rise to future difficulties so far as cattle breeding is concerned. Provinces which suffer from the want of a highly productive breed try to meet this want by importing animals of a better breed but the attempt is usually unsuccessful, because unless fodder of good quality is available, it is impossible to maintain constitution and milk yield.

Attention has already been drawn to the fact that natural pasture in many parts of the country is deficient in lime and phosphorus. Whether there is a deficiency of any other mineral is not definitely known, but this is probable, particularly in the case of sodium and chlorine. Iodine is also deficient in the soil of many parts of the country and cases of goitre in calves, which were cured by the administration of potassium iodide, have been reported from Pusa. Iron deficiency is also likely in some places, though no definite information is available, but it is interesting to note that there is a good percentage of iron oxide in the natural salt licks occurring in the Bombay Presidency. Moreover there is a relative deficiency of manganese in certain kinds of cereal products produced in India, but how far this affects the health of the cattle population in the various provinces cannot be stated at present.

III.—Vitamin requirements

The question of vitamins has assumed a place of very great importance in the study of human nutrition because in human dietary artificially prepared foodstuffs have displaced natural foodstuffs to a great extent. In the case of cattle this has not happened but the problem of vitamin addition in their rations has also to be considered in any study of cattle nutrition, especially where animals are stall-fed throughout. In an article on "Mineral Metabolism of Farm Animals", written about three years ago and reprinted in the *Indian Journal of Veterinary Science and Animal Husbandry*, Vol. 3, pp. 276-290 (1933), the present writer reviewed the position of vitamin requirements of animals and came to the conclusion that this

A case of osteomalacia in a Deccan village. Note the emaciated condition. Malformations on the ribs are not well seen in the photograph

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question was relatively unimportant with grazing animals, but that in the case of stall-fed animals vitamin additions (mainly A and D) might be necessary. The position now appears to be not quite so simple, and experimental work, as well as the results of observation in the field, suggest that a reconsideration of the question is necessary. It seems in fact that even under natural conditions of grazing there may occur a vitamin A deficiency capable of giving rise to nutritional disorders. Laboratory experiments on the feeding of mature animals with rations, in which the vitamin content has been partially destroyed, show that although no definite symptoms of a deficiency disease can be produced within six months yet the animals will lose condition and become dull and unthrifty. In Plate X, figs. 1 and 2, the condition of a Sahiwal cow, Susheila 146, before the start of the experiment and six months after, is shown. The animal was in calf before she was brought under this experiment and went down considerably in condition after the birth of the calf, but the addition of cod liver oil, which has a high vitamin A content, was very effective in bringing her back to condition.

Considerable evidence has been brought forward in the last few years by American and South African workers that vitamin A deficiency in the ration of cattle may give rise to serious difficulties. In my previous paper a mention was made of the occurrence of "blindness in calves" and abortion in cattle in some parts of India. It has been reported recently by South African workers that when heifers were kept on deficient diet, almost all of them gave birth to weak and blind calves and the cause has been tentatively assumed to be due to vitamin A deficiency in the ration. The occurrence of ophthalmia in cattle has also been reported by American workers and a group of Californian investigators has observed the important fact that there is a possibility of vitamin A deficiency in cattle under natural conditions of grazing and the most important manifestations of vitamin A deficiency are expulsion of the fetus prematurely or dead at term, severe diarrhœa in new born calves, and ophthalmia in growing animals. It is unfortunate that practically no work on this subject has so far been done in India, but we consider that a study of the effect of a vitaminosis A in cattle of this country is urgently required and is likely to yield results of great practical importance.

IV.—Malnutrition and disease-susceptibility of animals.

Enough has been said to show that various diseased conditions are produced when cattle are reared on rations which are deficient in certain constituents. Thus the existence of goitre, osteomalacia and other bone troubles, emaciation, birth of weak calves and pica has been ascribed to malnutrition and require no further mention. Since the classical investigation of the South African workers has shown that Lamsiekte is an indirect result of phosphorus starvation in cattle, and that Stiffsiekte is due directly to mineral deficiency, it has become generally recognised that there are other diseases, often imperfectly understood, which are dependent, at least in certain stages, on the deficiency of some important material in the ration.

FIG 1 Susheila 146 Sahiwal on normal ration prior to the start of the experiment

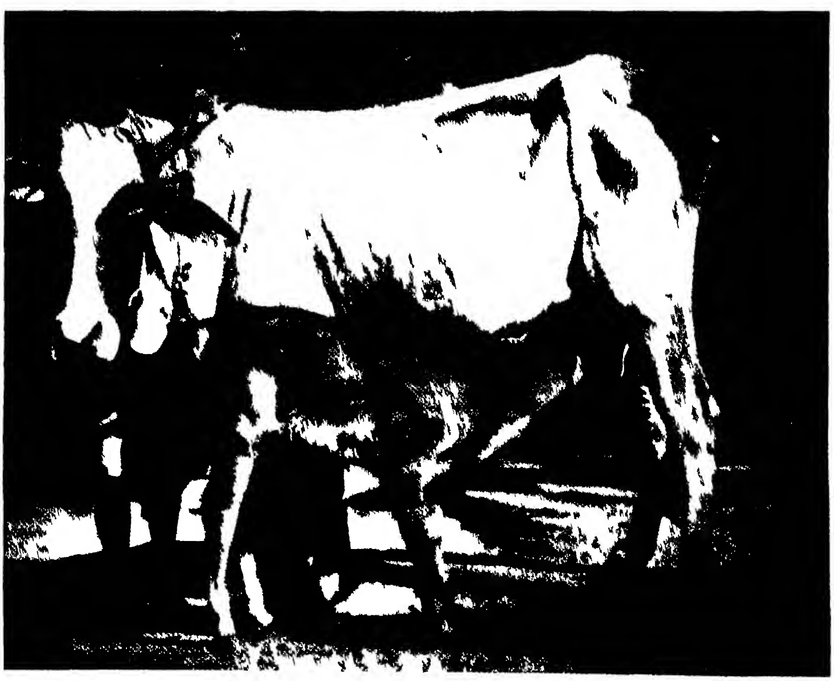


FIG 2 Susheila 146, after about six months on an autoclaved dairy ration Stall-fed throughout and allowed direct sunlight everyday Note the dull and emaciated condition

The fact that traces of iodine are now being used as a general prophylactic in the case of sheep and lambs in many countries may be cited in this connection and it is important to note that though a definite disease often cannot be diagnosed, a better dietary sometimes leads to an improvement in the condition of the animals, thus showing that the existing state of nutrition did not conform to the optimal growth of the animals. The general observation that the majority of the cattle in this country are unthrifty and emaciated, that mortality is high, sterility is common and productive capacity is low, suggests that malnutrition is probably the greatest single factor of importance in the causation of this degeneracy. The importance of this subject from the point of view of animal husbandry is thus obvious.

There is now a considerable amount of evidence to show that natural immunity to contagious disease is dependent on the nutritional state of the body and that diet has a definite effect on the increased resistance or decreased susceptibility of an animal towards an invasion by certain types of micro-organisms, but as yet we do not understand fully the relation between diet and incidence of infection. The experience of different groups of investigators, however, shows that any improvement in the quality of the ration by the incorporation of material deficient in the natural foodstuffs markedly enhances resistance. Thus the South African workers found that the addition of phosphates to the phosphorus-deficient feed of the cattle resulted in a decreased rate of mortality. Aberdeen workers have found that when the pasture is good, the natural antibody response is greater than when the ration is unbalanced. An important observation has been made at the Nutrition Institute, Coonoor, that animals living on imperfect diets show a greater tendency to infections of the respiratory and gastro-intestinal tract, and that there is a tendency of stone formation in the bladder, and the Aberdeen workers have found that the parasitic flora of the intestine is increased when animals are kept on a deficient ration. In the case of our half-starved indigenous cattle of low productive capacity, this disease-susceptibility does not often attract our attention, but striking after-effects of malnutrition are seen in the case of imported breeds or indigenous animals of good breed and high milk yield. With the development of modern methods of animal husbandry, the objective has been to obtain the utmost return from farm animals in the shortest space of time, and this has introduced many complications in their rationing. It is not difficult to provide sufficient amounts of proteins, fat or carbohydrates for this type of intensified production, but the deficiency of vitamins and mineral matter in the locally available foodstuffs raised on poor soil has resulted in the partial malnutrition of the animals, and has been one of the predominating causes of weakened resistance to disease. It should be realised by every nutrition worker that there is a "threshold" value for adequate nutrition, that there may be a veiled malnutrition indicated only by a falling short of full development and by a latent weakening of resistance to infection and exposure. It is now widely accepted that a great loss of body calcium is a predisposing factor in the greater incidence of certain diseases in heavy milking cows such as milk fever, tuberculosis and Johne's disease. Other types of losses such as those resulting from irregular breeding and

abortion of non-infectious origin, which are quite common in India, are also probably due to faulty dieting on a calcium and vitamin A deficient ration.

The possibility of mineral deficiency being a predisposing cause of Johne's disease in heavy milking cows has just been mentioned and as Johne's disease is rapidly spreading in India, an experiment on the effect of mineral feeding to dairy cows, which is being carried out at this Institute, will be of interest to practical farmers. The experiment has now been going on for three and half years in a herd infected with Johne's disease, and the most striking result which has so far appeared is that we have lost about 30-35 per cent of the control cows from this disease, but, with the exception of one doubtful case, not a single animal belonging to the mineral-fed group has been found to be suffering from it. In Plate XI, figs. 1 and 2, two cows representing these two different batches of animals after three years' experimentation are shown. The difference in their condition is too obvious to require comment.

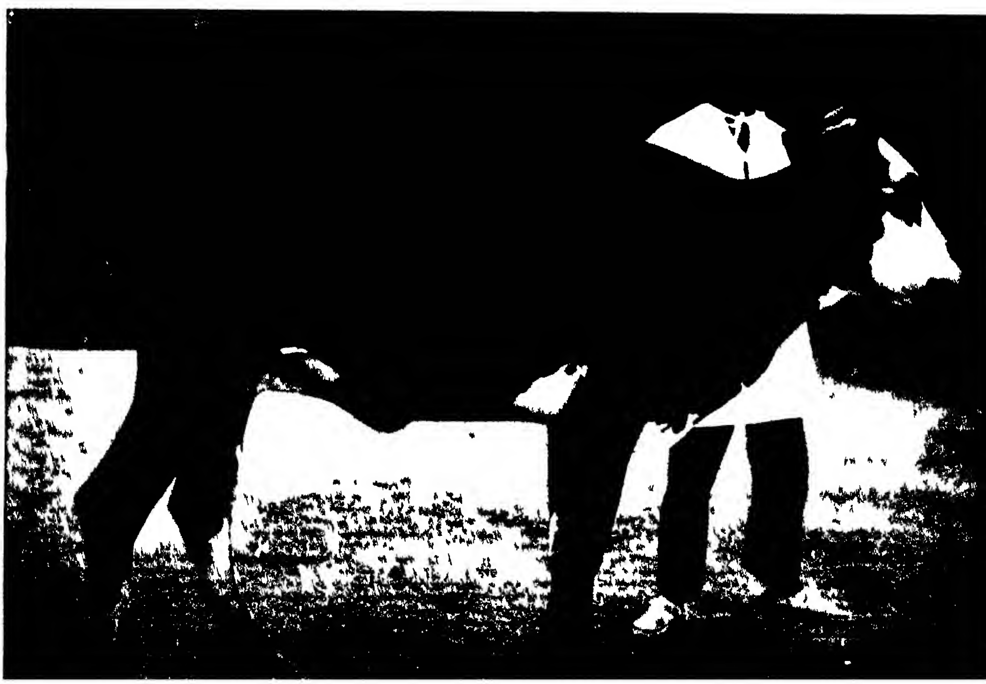
CONCLUSION

In the foregoing pages I have dealt with the subject of malnutrition in cattle, but it is extremely important to remember that there is an intimate connection between soil poverty, malnutrition in cattle and malnutrition in human beings. The last subject has been studied in this country for a great many years by Sir Robert McCarrison, and in concluding this article, I cannot do better than quote a few paragraphs from his evidence given before the Royal Commission on Agriculture in 1926 :—

" Malnutrition is thus the most far-reaching of the causes of disease in India. It is one of the greatest—if not *the* greatest—problem with which the investigator of disease is faced. It is, too, the chief among the problems facing those engaged in agricultural research. The ultimate aim of both is the same : the adequate nutrition of the people. So far then, from agricultural and nutritional research being carried out in isolated compartments, there should be the closest co-operation between them, to the mutual advantage of each and to the widening of scientific vision.

It is not alone in regard to human subject that malnutrition exerts such harmful effects. Man's domestic animals suffer no less than he himself. It suffices in this connection to refer to the effect on cattle of pasturage which is deficient in certain mineral ingredients. As an example of this kind the now well-known effect of deficiency of phosphorus in the soil, and, therefore, in the vegetation, on the health of cattle and sheep may be mentioned. Such deficiencies exist in large tracts throughout India as, for instance, in the soils of Bihar. In India, unfortunately, millions of stock exist in a state of semi-starvation. As draught animals they are consequently inefficient, and as producers of milk and milk products—so essential as food for mankind—they are more inefficient still.

Fig. 1. Kaluli 74. Holstein-Sindhi, one of the typical mineral-fed dairy animals after three years of experiment.



There is, perhaps, no more important department of agricultural and nutritional research than that which deals with animal husbandry; and here I should like to emphasize that the problems of animal husbandry are also the problems of human husbandry.

Human and animal inefficiency is reflected in the soil; in its imperfect cultivation; in inadequate manuring; and in crops scanty as to quantity and deficient as to quality. Too few animals are kept by the cultivator, as the scanty vegetation cannot support them; and so there is returned to the land too little of that organic matter, in the form of farmyard manure, on which the continued fertility of the soil is dependent. It has been shown in regard to plants, as in regard to animals, that they cannot thrive, nor their seed attain to the fullest "reproductive quality" unless they be provided, in addition to the mineral constituents of their food, with certain organic substances known as "auximones". These substances which are akin to vitamins are as essential to the normal metabolism of plants as vitamins are to the normal metabolism of man and animals. They not only enable the plant to build up from the simple ingredients derived from the soil those organic complexes required as food by men and animals, but they enable it to elaborate vitamins without which these organic complexes cannot be utilised by the animal organism. Auximones are produced in the soil from decaying organic matter by the action of certain soil bacteria; and the best organic matter for this purpose is farmyard manure. So it is that such disabilities of mankind as are due to faulty nutrition are sometimes traceable to the soil itself, which has become exhausted and unproductive of the best kind of food through improper attention and cultivation. Malnutrition, thus, pursues its harmful course in an ever-widening vicious circle; the cultivator is too often ill-nourished and ravaged by disease which is commonly the result of his ill-nourishment; his beasts are alike ill-nourished; while both toil wearily in a heartless effort to extract from the ill-nourished earth enough to keep them from starvation. The solution of the problem of malnutrition is thus, to a great extent, one of improvement in methods of agriculture."

REFERENCE

Sen, K. C. (1933). *Agric. and Live-stock in India*, 3, 549.

WATER HYACINTH

BY

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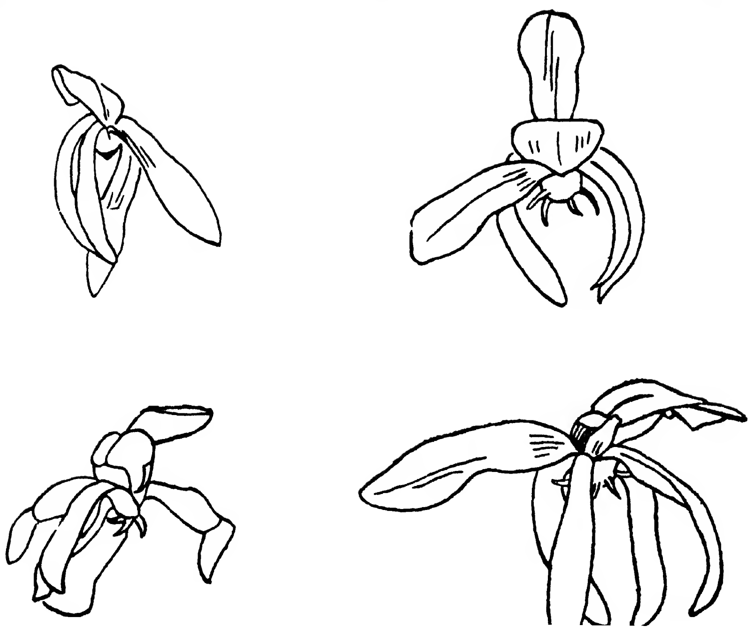
It is well known how this exotic weed has become a pest of the countryside. This pest has rapidly spread in its country of adoption. The plant is eminently fitted for life in water. The long and ample roots act as ballast. The swollen leafstalks act like floats and the hoodlike leaves as sails and the plant careers about on the water surface, thus being helped in its distribution.

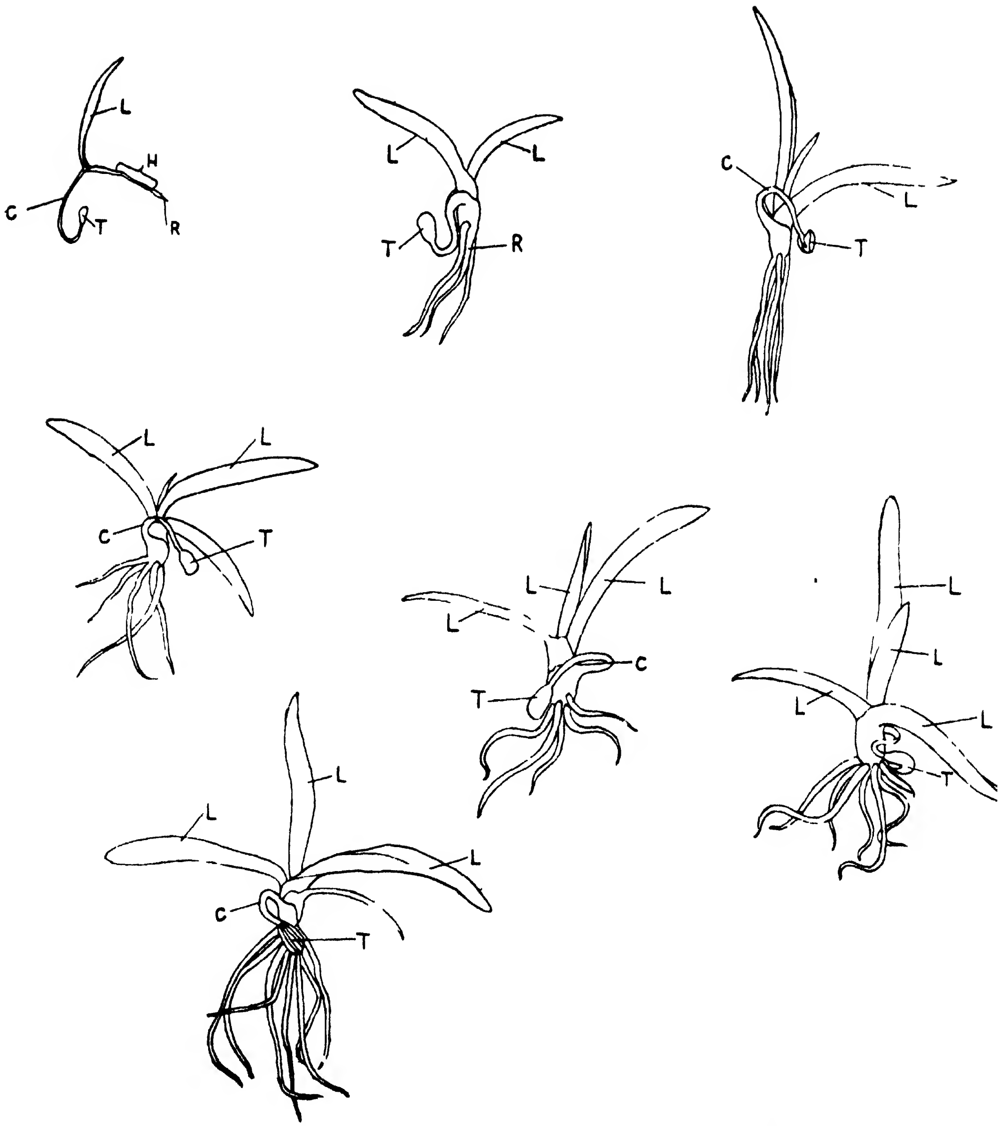
There are two ways of reproduction. The main rootstock produces slender off-shoots, which end in a rosette of leaves and a tuft of roots. If the slender stalk breaks on account of strong breeze or waves, the broken rosette becomes an independent plant. The plant thus multiplies without any seed production and this method of multiplication is so common and so fast that it is regarded as the only way of reproduction. In clearing operations, care must be taken to remove all traces of this plant, because any joint or rootstock left in water will soon lead to the reappearance of the plant in the cleared stretch of water. In fact the spread is so quick that it has been considered a mysterious process and has led to the supposition that even roots reproduce. This belief is certainly wrong as has been proved by experiment. This modo of asexual reproduction prevails wherever the water hyacinth occurs.

There is, however, a second, though not so apparent or common, method of reproduction and that is by seed formation. In hot and humid regions like Orissa and Burma, it has been seen that water hyacinth appears in tanks which were scrupulously cleared. This was mystifying the executive officers in charge of clearing operations till seedlings were observed. The seedlings appear on wet mud on he tank-sides and as the water level rises, the tops of seedlings break away from the root-stock and float up. (Plate XII.) These floating rosettes produce new roots and become independent floating plants ready to reproduce by producing stolons which break off.

It is clear, therefore, that this mode of reappearance of the weed should be borne in mind in clearing operations. It is not sufficient to take out all the plants and destroy them. One must be vigilant from year to year, as the weed is likely to appear from seeds which have been lying at the bottom of tanks. It has been found that seeds may be dormant for several years at least seven years without losing their vitality, when, in any year of drought, the tank dries up, the seeds germinate after the first shower of rain. The seedlings grow rapidly with the rise in level of water up to a limit and then they get submerged. In a day or two the seedlings break off the root-stock neatly and float up. Near the clean surface of breakage new adventitious roots come out and the plants are established as floating organisms.

FIG. 1





The various stages of the seedlings of the water-hyacinth. T, testa ; H, hypocotyl ; C, cotyledon ; F root ; R, leaf. (Free hand drawing natural size.)

FIG 1 Water-hyacinth showing two bent spikes (B S) with fading flowers immersed in water, ready to discharge ripe seeds in the water from ripe capsules

FIG 2 Water-hyacinth showing two erect spikes (E. S), with flowers

If the tanks are to be kept free from water hyacinth they must be cleared from year to year till the dormant seeds are exhausted. The question is as to the time of the year at which clearing must be done.

The most suitable time will be suggested from the facts of seed production and germination which are given below. The water hyacinth flowers almost throughout the year. Flowers are particularly abundant during the rains and the spring. When the flowers wither, the spike bends down in the form of an inverted S and often its tip dips into water. (Plate XIII.)

Although careful search has been made in these plants for fertile capsules in spring and early rains, no capsules have been found. Fertile capsules appear only towards the end of October and November The temperature at this time seems to be suitable for seed formation. These capsules burst when mature and discharge the seeds into water. The seeds are heavier than water and sink to the bottom of the tank or pool and lie dormant there If in summer the bottom of the pool dries up, the seeds lying there sprout after a shower of rain. It will thus be seen that the danger from seeds can only arise in autumn when the fruits mature. If clearing can be done in August and September, the flowers cannot get a chance to set seeds and the danger of re-infection from that source can be avoided.

One may be tempted to clear the seedlings early in the rains, but the difficulty is rather great. First of all, the seedlings (Plate XIV) are likely to be mistaken for grass for one or two months from sprouting. Secondly, even when they float up after submersion, they may lurk among other water weeds and make the search difficult and tedious All this can be got over if clearing is done after the plants attain maturity and before they set seed.

Another way of checking seedlings is to keep the tanks, etc., full of water throughout the year, but that is not practicable.

As to the method of clearing, there seems to be only one sure method and that is mechanical. Chemical spraying in order to be effective must consist of strong chemicals and these introduce other complications like killing water animals and making the water poisonous for cattle. Mild sprayings only check the growth. Mechanical clearing should be thorough and care must be taken to ensure killing the plants thus collected. Otherwise a chance root-stock left alive is capable of repopulating the whole stretch of water in one or two years This plant has remarkable power to adapt itself to life in dry situations as well as in free water. A root-stock thrown in mud will strike roots and as the mud dries, the plant adjusts itself to a land life and waits for the chance of getting into water when it comes. Although attempts at clearing have been repeatedly made, despairing failures have resulted from the presence of seeds in the mud and also from neglected living root-stocks. The clearing operations in Orissa had the merit of being very thorough. The authorities were aided by District Board by-laws and negligent owners of tanks and pools were prosecuted.

A STUDY OF THE EFFECT OF THE CLIMATIC SEASONS ON CERTAIN PHASES OF SHEEP HUSBANDRY AT THE GOVERNMENT CATTLE FARM, HISSAR

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In practically all the districts of the Punjab sheep are bred throughout the whole year and the ram is allowed to run at all times with the ewes. The result is that the ewes lamb haphazardly in seasons when there is a lack of food and also when adverse climatic conditions prevail. This affects the health of the ewes, the lambs do not grow and mature properly, and the overprolific ewe dies an early death.

It has been found by long experience at the Government Cattle Farm, Hissar, that better stock can be produced when the ewes lamb once a year only.

The advantages of this system are—

(1) The lambs are born at the time desired and are approximately all of the same age and develop uniformly. It can be so arranged that they are dropped in a particular season when nourishing food is available in abundance.

(2) All the lambs arriving within a definite period, besides allowing more efficient supervision and better arrangements made for their comfort and development give the ewes complete rest before the next mating and suckling period.

(3) The lambing can be arranged in the season most suitable for grazing and flushing. Thus the ewes which are in a thriving condition during the mating period can give a good start to the foetus which is likely to develop into a healthy and strong lamb.

(4) All the ewes lamb almost together, which results in the production of lambs of much greater uniformity of age and size.

(5) The marketing of the fat lambs, which are not up to the stud standard, can be arranged to fit in with the time of the year when the prices are the highest, which is in the cold weather.

(6) The young stock is of the same age; hence if simultaneously shorn, the growth of wool will be almost uniform in length and for the reason will command a better price in the market.

(7) A good resting period can be provided for the ewes which are to be called upon to run through a strenuous programme of production, in the course of which besides requiring energy for the maintenance of their own bodies, they have to get in good condition for their future lambing period, to develop the foetus, to suckle the lambs, and above all to produce wool.

(8) The young lambs are dropped at a season when extreme climatic conditions are not prevalent.

(9) The lambs can be weaned at a particular time and looked after economically.

(10) The male lambs can be separated from their mothers at the proper time and age.

(11) The lambs can be shorn when one year old and at the same time as the rest of the flock. Their wool can be marketed with the general crop and the zamindar will not lose by selling wool of different lengths.

(12) The rams are not overworked, will live a longer life, and will be capable of producing a larger stock possessed of outstanding merits.

With a view to finding out the best breeding season under the climatic conditions prevailing at Hissar, the authorities here have tried different times of the year of breeding. The first attempts were to get a crop of lambs in the early spring season, as suggested by Mr. Branford, the late Superintendent of the Farm, in leaflet No. 42 of the Department of Agriculture (Hints on the Management of Sheep in the Punjab) :—

> "Usually grazing in the province is very scanty in the cold weather, if that is the case the lambs born in January and February will die. The ewes have insufficient milk and the lambs die of pneumonia and malnutrition. It is much better to arrange for the ewes to lamb in the spring at the time *rabi* crops are being harvested. Grazing is generally good then in the stubbles and the lambs get sufficient milk and do well."

In the above system (as the ewes are in lamb for about 5 months) the rams were put on in September and kept on up to the month of December. The crop of lambs was dropped from March to May. It was thought that this system of sheep husbandry could be improved upon and so the time of lambing was changed.

Hissar has a climate of extremes. It is situated in the north-west dry region of India. The annual rainfall is 14 in. only which is generally badly distributed. The average rainfall in the different quarters of the year is as follows :—

	Inches.	
First quarter	1·59	Average of the last 10 years.
Second quarter	2·09	
Third quarter	13·24	
Fourth quarter	1·02	

On account of low rainfall, the sheep at the farm are grazed on the fallows after the crops have been harvested from the irrigated areas.

In this system it was found that many of the lambs born in early March were badly attacked by pneumonia while some of those born in May could not stand the intense heat and died of heat stroke and contagious aptha.

It was thought that a better time for lambing could be evolved and so an experiment was made in 1928-29 and the breeding season was changed by putting the rams on from the middle of March to the 15th of June, thus getting a crop of lambs from the first week of August up to the end of October. This experiment proved successful and so the time of breeding was changed and the lambs are now dropped from the first week of August to the end of October.

The merits of the second system have been established and we are now getting a good crop of lambs with a very low percentage of deaths.

Table I appended gives a comparative statement of the breeding results, obtained for three years from each system. These six years extend over the period between the year 1927-28 and 1932-33. Though the average percentage of births in both these periods is 81, the average percentage of deaths in the former period is 19·5 while that in the second is 5·5 per cent or about ¼th of the first.

The high percentage of births (86·1 per cent) shown against the year 1930-31 is very interesting and remarkable. One would naturally have expected a low percentage of births in the second period as the ewes had already dropped a crop of lambs in the earlier part of the year, when 81·4 per cent of the ewes had actually lambed from March to May. The ewes after lambing were well "flushed' in the *rabi* crop stubbles, had suckled their lambs and then lambed again, which proves the superiority of the period of March to June as far as the availability of nourishing food is concerned. The year 1930 was an exceptional one for rain as it rained 1·31 in. on the 14th of June and 16·64 in. of rain fell in the period of June, July, August and September.

The development of the lambs born in the period of August to October has been found to be greater than that of lambs born from March to May.

The different annual phases in sheep husbandry can be divided as follows :—

(*i*) Flushing, covering and bearing season. This is the period in which the ewes are actually prepared for being covered, and the mating actually takes place.

(*ii*) The lambing period. The period in which the ewes actually drop their lambs.

(*iii*) Suckling period. The period in which the ewes suckle their young.

(*iv*) The resting period. The period in which the lambs are weaned and the ewes get complete rest so far as breeding is concerned.

According to the above divisions of the breeding activities of sheep the most important seasons are the first and the third, *i.e.*, (*a*) the flushing, covering and bearing period, (*b*) the suckling period.

Each of these periods should naturally be arranged to fall in the season when the climatic conditions are most suitable and when there is an abundance of grazing. For the canal irrigated areas where sheep farming industry is only a secondary enterprise such periods are found just after the harvesting of the *rabi* and *kharif* crops.

For practical considerations the year can be divided into four quarters—

First quarter.—(January, February and March) when the *rabi* crops are growing and very little grazing is available.

Second quarter.—(April, May and June). The *rabi* crops are harvested and there is plenty of grazing on the stubbles.

Third quarter.—(July, August and September). The *kharif* crops are growing but there is at the time plenty of grazing on account of rains and also there is a good supply of canal water which can be used if required for growing grass on the fallow lands.

Fourth quarter.—(October, November and December). The *kharif* crops are removed and there is very good grazing in the stubbles.

A comparative statement of the different phases of sheep husbandry in the former and the present system

Quarter No.	Breeding periods	
	Former system	Present system
I. The period of January, February and March	Lambing and bearing period	Resting period
II. The period of April, May and June	Suckling period . .	Flushing, covering and bearing period
III. The period of July, August and September	Resting period . .	Lambing and bearing period.
IV. The period of October, November and December	Flushing, tupping and bearing period	Suckling period

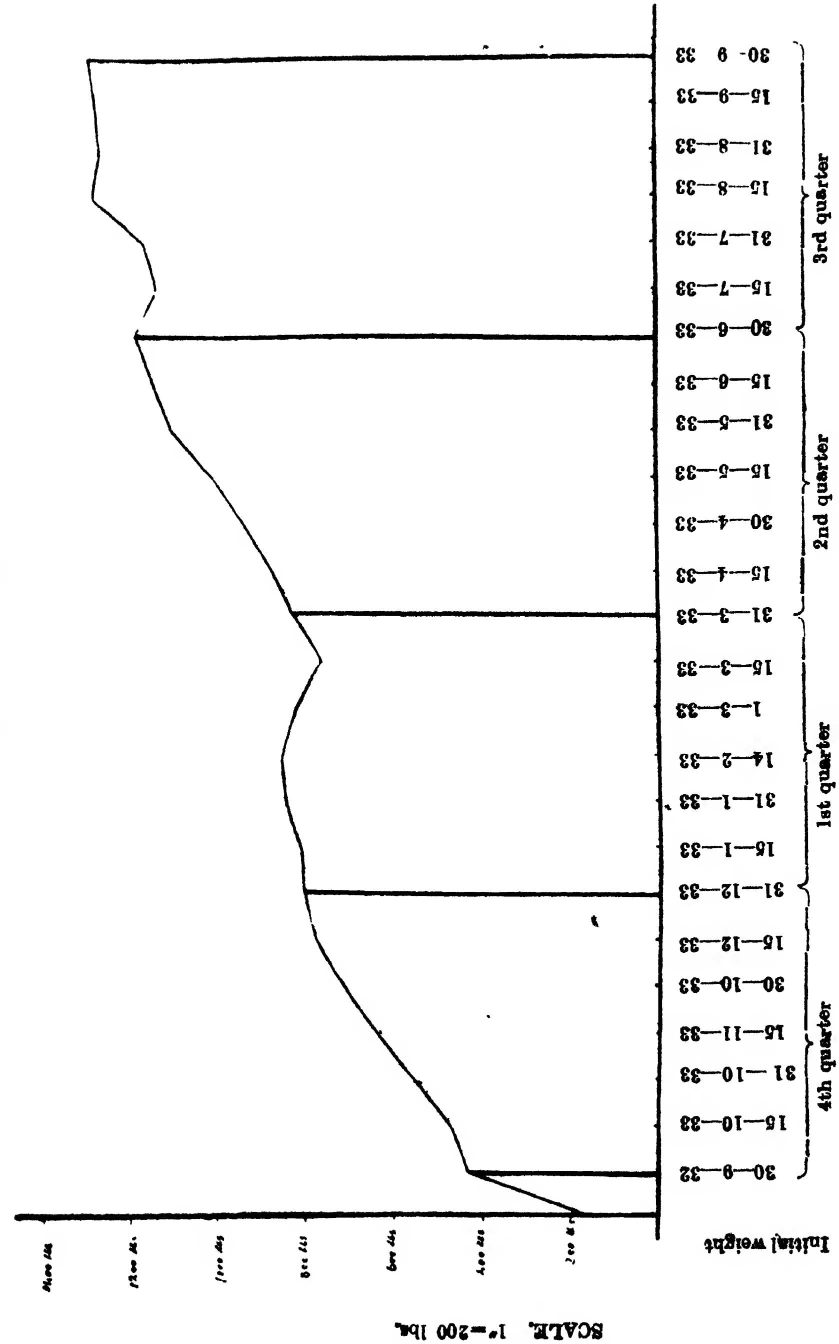
According to the above statement the second and the fourth periods are the best for conditioning the ewes as there is plenty of grazing available in both of these periods. The inference is further justified by the data collected in our two further experiments regarding (*a*) the growth of young lambs, (*b*) the monthly wool growth in the case of Bikaneri and Hissar Dale ewes at the Government Cattle Farm, Hissar.

In each of the above mentioned experiments, the animals used were not given any special food and were allowed to run with the main flock.

As shown in Table II appended and Fig. 1, eighteen young male lambs of the same age and weight were selected in September 1932, out of whom twelve were castrated when three weeks old and six were kept entire. Their growth was studied by weighing them every fortnight. They were approximately of the same age and weight at the time the experiment was started. It was however found that the accumulative gain of weight per day in the case of all the eighteen lambs was 0·22 lbs, 3·9 lbs, 1·1 lb and 3·9 lbs in the first, second, third and fourth quarter respectively. In this experiment too, the bests growth was obtained when there was an abundance of food after the *rabi* crops in the second quarter of the year and after the *kharif* crops in the fourth quarter.

A GRAPH SHOWING THE FORTNIGHTLY GROWTH OF EIGHTEEN LAMBS FOR ONE YEAR.

(12 castrated and 6 entire)



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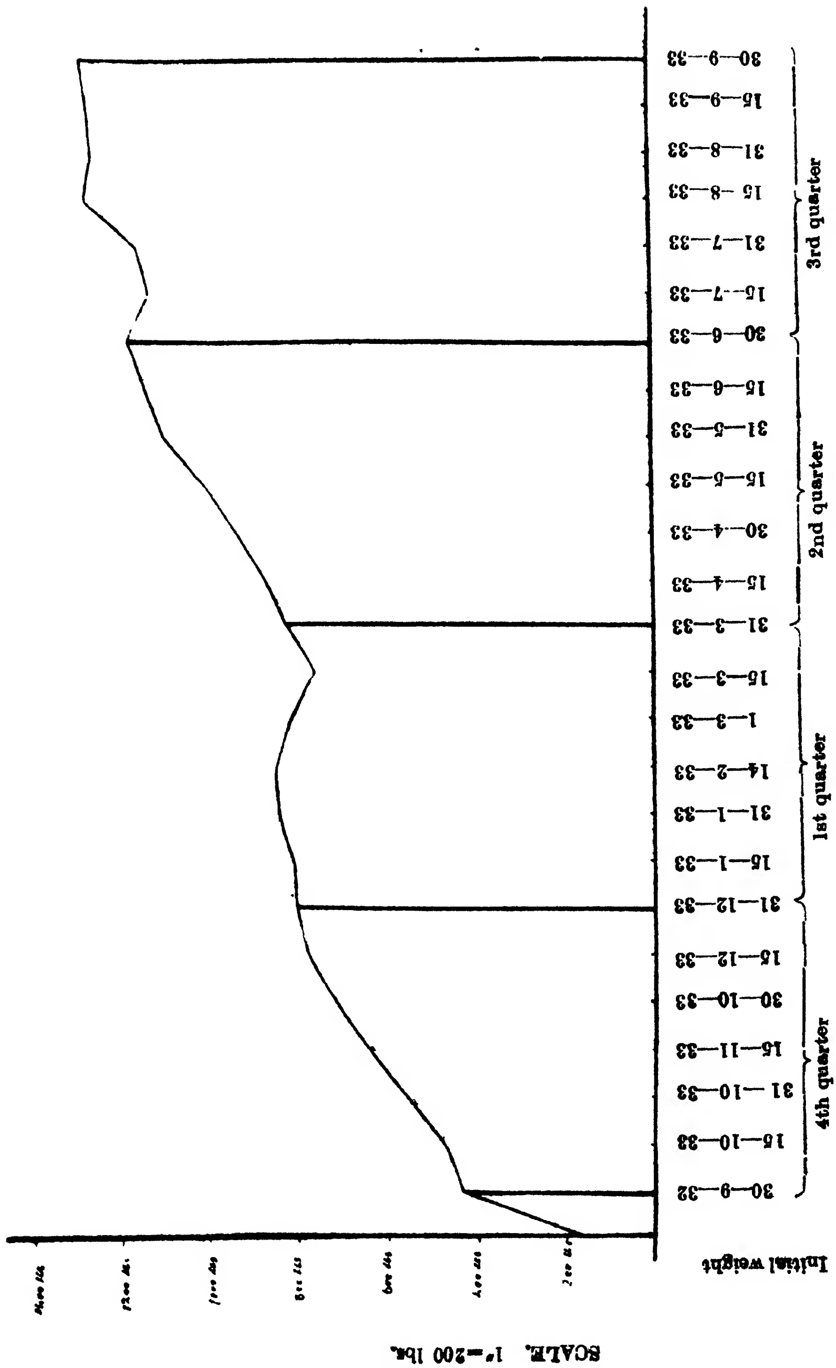

Similarly in the wool growth experiment (Table III) the growth was maximum in the second and fourth quarters and minimum in the first and third quarters in the case of both the Hissar Dale and Bikaneri ewes.

Taking into account the above scientific knowledge, the shepherd has the choice of starting his mating operations in either the second or the fourth quarter.

But it has been found that the second quarter is the best for mating as the ewe can be well flushed by grazing them on the *rabi* stubbles. The ewes are required to improve their condition before the lambing season commences, therefore they are more likely to come in heat if they are flushed. A thriving ewe stands a better chance of producing a vigorous offspring.

The fourth quarter is the best period as far as the availability of green food for grazing the young lambs is concerned. Out of the remaining two quarters, the third quarter produced a far better growth both as regards weight and wool, as it includes the months of July, August and September which usually receive more rainfall and in which there is usually a better canal supply which provides good grazing in the fallow lands.

The whole breeding season, from the practical point of view, extends over about a period of nine months or three quarters of a year. The ewes require about two months for flushing, five months for bearing, and about three months for suckling their lambs. The shepherd has, therefore, to make a choice of any three continuous quarters.

As shown in the above mentioned tables on the growth of the young lambs and wool growth, in both cases, the growth is the lowest in the first quarter of the year, comprising the months of January, February and March, when the grazing is the least and the animals have to consume a good part of their stored fat to produce sufficient heat in order to protect themselves from cold.

A closer study of the table on the growth of lambs will show that in three out of six fortnightly weighings in the first quarter, there was actually a loss of weight. There was only 0·22 lb of accumulative gain in weight per day in eighteen lambs in the first quarter as compared with 3·9 lbs, 1·1 lb and 3·9 lbs of accumulative gain per day in the case of the eighteen experimental lambs in the second, third and fourth quarters respectively.

This further proves that in the first quarter the ewes should be subjected to as little strain as possible.

The local shepherds believe that if a ram is left with the flock he may desert them in the very cold months and wander away in search of food rather than remain with the ewes for mating, therefore it would be extremely unwise to include the first quarter of the year in the most important period of flushing, covering, bearing and suckling.

The scarcity of food, the severity of climate, and its close proximity to the real breeding season demand that during this period, *i.e.*, first quarter when the climate is so unfavourable, the breeding ewes should be given a complete rest to prepare

themselves for the next lambing season. In this season the mere maintenance of the body and production of a good crop of wool should be considered sufficient.

As compared with the first system it has been found in the latter system that the cases of shortage of milk amongst the ewes were few and far between. The ewes which were overstrained in the first quarter in maintaining their bodies in the inclement weather, in developing the foetus and in growing wool, could not produce sufficient milk to nourish their lambs and in many cases disowned them.

Conclusions

1. The period of January, February and March (first quarter) should always be reserved as a period of rest for the ewes, as during these months the weather is very cold and the grazing is scarce.

2. When producing one lamb a year the rams should be put with the ewes from the 15th of March to the 15th of June, so that the lambs will be dropped between the first week of August and the 15th of October. In this way the ewes will get the *rabi* stubbles and weeds in the flushing and tupping period, and the *kharif* stubbles and weeds for themselves and their lambs in the suckling period.

3. The lambs should be weaned at three months of age to enable the ewes to get sufficient rest before the next tupping season.

4. The ewes give the best results when tupped in (March to June).

5. There is less mortality among the lambs born from August to October.

6. The lambs attain a greater growth when dropped in the above period (August to October).

7. The growth of wool is less in January, February and March (first quarter) and July, August and September (second quarter) and October, November and December (fourth quarter).

8. The growth of lambs is less in the first and third quarters of the year and more in the second and fourth quarters of the year.

9. The lambs produced within a given period are ready for shearing at the same time, and the wool is of a more uniform length.

10. If lambs are dropped in the third period they are ready for the market in the next cold weather when there is a greater demand and transportation is a less serious problem.

11. Haphazard breeding is undoubtedly uneconomical.

12. If the zamindars require two crops of lambs a year, they should arrange to get their ewes tupped in from the 15th of March to the 15th June and the first crop of lambs will be dropped from the first week of August to the end of October.

For the second crop the ewes should be tupped from September to November and a crop of lambs will be dropped from the middle of March to the end of May. In this way the lambs will be born when there is plenty of good grazing.

13. During the period the rams are not tupping they should be segregated from the flock and when this is not possible an apron made of old bag or thick cloth should always be kept hanging under the belly to prevent mating.

TABLE

Statement showing the breeding results obtained

Year	Total number of ewes put to the ram			Lambed				Percentage lambed
	H. D.	Bik.	Total	H. D.		Bik.	Total.	H. D. and Bik. combined
1927-28 . .	493	14	507	January .	21	..	380	77
				February .	5			
				March .	132			
				April . .	125			
				May . .	52			
				June . .	44			
				July . .	1			
1928-29 . .	476	14	490	March .	289	12	439	86·5
				April . .	104	6		
				May . .	6	7		
				August .	15	..		
					414	25		
1929-30 . .	488	60	548	March .	286	39	446	81·4
				April . .	91	10		
				May . .	18	..		
				June . .	2	..		
					397	49		
1930-31 . .	386	155	441	September .	46	63	380	86·1
				October .	153	36		
				November .	37	17		
				December .	11	16		
				January .	1	..		
					248	132		
1931-32 . .	410	164	574	August .	199	97	470	81·9
				September .	93	46		
				October .	12	7		
				November .	15	1		
					319	151		
1932-33 . .	466	223	689	August .	209	131	531	77·0
				September .	138	17		
				October .	22	9		
				November .	5	..		
					374	157		

t.

in the different breeding systems

Deaths			Percentage deaths	Serving period of the ram	Lambing period of the ewe	Remarks
H.D.	Bik.	Total	H. D. and Bik. combined			
53	..	53	13·9	September to November	8th March 1927 to 2nd June 1927	
168	9	177	40	Ditto .	1st March 1928 to 31st May 1928	Average births 81 per cent Average deaths 19·5 per cent
15	6	21	4·7	Ditto .	12th March 1930 to 29th May 1930	
19	3	22	5·7	March to June	23rd September 1930 to 16th December 1930	
30	5	35	7·4	Ditto .	12th August 1931 to 24th October 1931	Average births 81·6 per cent Average deaths 5·5 per cent
16	3	19	3·5	Ditto .	4th August 1932 to 25th October 1932	

TABLE

Statement showing the growth of the 18 young male lambs

NOTE:—Accumulative age on 30th Septem

No. of group	Initial weight, in lbs		Date of weighing	4th quarter 30th Sept. 1932 to 31st Dec. 1932 Suckling period					
				Fort-					
				1	2	3	4	5	6
				15th Oct. 1932	31st Oct. 1932	15th Nov. 1932	30th Nov. 1932	15th Dec. 1932	31st Dec. 1932
I. Castrated by Burdizo	51	144	Total group weight . .	153	188	227	250	254	265
			Fortnightly gain or loss .	+9	+35	+39	+23	+4	+11
II. Castrated with teeth	57	146	Total group weight . .	161	192	216	242	258	265
			Fortnightly gain or loss .	+15	+31	+24	+26	+16	+7
III. Entire control .	52	142	Total group weight . .	156	193	211	241	254	265
			Fortnightly gain or loss .	+14	+37	+18	+30	+13	+11
			Total growth of all the groups fortnightly	+38	+103	+81	+79	+33	+29
Total growth in a year of the three groups	= 853 lbs.		Total seasonal growth of 3 groups	363 lbs					
Average growth per day	= 2·3 lbs.		Growth per day per quarter .	3·9 lbs					
			Percentage of growth per quarter	42·5					

II.

(12 castrated and 6 uncastrated) in one year

ber 1932 was 29 weeks in each case

1st quarter 1st Jan. 1933 to 31st Mar 1933 Resting period						2nd quarter 1st Apl. 1933 to 30th June 1933 Flushing and bearing period						3rd quarter 1st July 1933 to 30th Sept. 1933 Lambing period					
night ending																	
7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
15th Jan. 1933	31st Jan. 1933	15th Feb. 1933	28th Feb 1933	15th Mar. 1933	31st Mar. 1933	15th Apl. 1933	30th Apl. 1933	15th May 1933	31st May 1933	15th June 1933	30th June 1933	15th July 1933	31st July 1933	15th Aug. 1933	31st Aug. 1933	15th Sept. 1933	30th Sept. 1933
267	275	283	274	259	272	295	331	343	370	384	388	375	383	423	419	425	434
+2	+8	+8	—9	—15	+13	+23	+36	+12	+27	+14	+4	—13	+8	+40	—4	+6	+9
265	279	286	270	265	276	291	318	334	364	378	388	379	383	408	412	415	42[illegible]
0	+14	+7	—11	—15	+16	+15	+27	+16	+30	+14	+10	—9	+4	+25	+4	+3	+5
257	271	281	271	247	267	275	307	327	365	376	399	381	394	444	417	421	431
—8	+14	+10	—10	—24	+20	+8	+32	+20	+38	+11	+23	—18	+13	+50	—27	+4	+10
—6	+36	+25	—30	—54	+49	+46	+95	+48	+95	+39	+37	—40	+25	+115	—27	+13	+24
20 lbs						360 lbs						110 lbs					
0·22 lbs						3·9 lbs						1·1 lb					
2·4						42·2						12·9					

TABLE III

Percentage of wool growth in different seasons in Hissar Dale and Bikaneri Ewes

Period	Hissar Dale	Bikaneri	Remarks
15th April 1932 to 29th June 1932	29·5	32·7	Flushing / Covering } period Second quarter
30th June 1932 to 30th September 1932	23·8	19·9	Lambing period . Third quarter
1st September 1932 to 30th December 1932	24·7	30·7	Suckling period . Fourth quarter
31st December 1932 to 12th April 1933	23·0	16·7	Resting period . First quarter

WHEAT RUSTS FROM THE VIEWPOINT OF PLANT BREEDING*

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In modern agriculture it is recognised that the production by the breeder of resistant varieties of crop plants is the most hopeful and, in the long run, the most economical method of controlling plant diseases. Fungicides and insecticides frequently afford temporary relief from disease but they are often expensive and sometimes difficult for the average farmer or cultivator to employ. When, therefore, in the early years of the present century, it was demonstrated by Biffen and others that, generally speaking, resistance to disease, like morphological characters, was governed by genetic factors amenable to the same laws of inheritance, it began to be realised that in the production of resistant varieties by systematic breeding lay the solution of the disease problem. Rapid and notable progress has been achieved since that time.

Among the most serious crop diseases, from the economic standpoint, are those of wheat occasioned by the three rusts, black, brown and yellow. According to Hayes and Stakman [1921] the average yield per acre of wheat in Minnesota fell from 15·4 bushels to 8·6 bushels in the epidemic years 1916, 1919 and 1920. Similar large losses are experienced, from time to time, in all the large wheat-growing areas of the world. The problem of the rusts, therefore, is one that looms large in wheat growing. Here, as in the case of many other diseases, the solution appears to lie in the breeding of resistant varieties Its attainment, however, has proved to be a more difficult task than was at one time anticipated. The reasons for this I shall now explain.

Wheats fall into three groups, characterised by differences in chromosome number as well as in physiological and morphological characters. The members of one group either fail to cross with those of another or cross with some difficulty. These groups are (1) the Einkorn group with $n=7$ chromosomes, (2) the Emmer group with $n=14$ chromosomes, to which *durum* and *turgidum* wheats also belong, and (3) the *vulgare* group with $n=21$ chromosomes, in which are included the common or bread wheats. Now whilst the economically desirable qualities are almost all concentrated in the last group, the only wheats resistant to most of the rust forms belong to the Emmer group, and, as stated before, members of different groups cross with difficulty. Subsequent segregation is often very complex owing to irregularities in chromosome behaviour. Many segregates are eliminated by

*Paper read at the Symposium on Cereal Rusts at a joint Meeting of the Botanical and Agricultural Sections of the Indian Science Congress, Calcutta, January 1935,

sterility occasioned by chromosome incompatibility and there is a tendency for the progeny to revert to one or the other of the parent types.

In 1920, Hayes, Parker and Kurtzweil found that resistance was dominant to susceptibility in crosses of *vulgare* varieties with *T. dicoccum* but in crosses of the former with *T. durum* susceptibility was dominant, and in the F_2 there was strong linkage between rust resistance and the Emmer or *durum* characters. But the important fact was established that some crossing-over occurred : this meant that it should not be impossible to transfer the resistance of the Emmer group to bread wheats.

Since then a large number of such crosses has been made and their genetics and cytology studied. These studies have yielded some very interesting information but it will not be discussed here as this lies outside the scope of the present brief account.

Another circumstance which contributed to the lack of success and slow progress in some of the early investigations was lack of knowledge of the existence, in the rusts, of physiologic forms, morphologically indistinguishable from each other, which vary in their ability to attack different varieties of wheat. Early breeders were puzzled by the failure of certain varieties to maintain their resistance from year to year, and in different localities. When, however, Stakman and Piemeisel [1917] demonstrated the existence of physiologic forms in *Puccinia graminis tritici*, the reason for these apparent breakdowns of resistance became clear. Most wheat varieties are resistant only to certain physiologic forms and the particular forms present vary from locality to locality and from year to year. Hence one can speak of a variety being resistant or susceptible only in a general sense.

About 130 forms of black rust are now known, and physiologic forms of brown and yellow rust also exist although their number is not quite so large. It has been found that these physiologic forms are quite stable, and that the origin of new forms obeys known genetic laws. New forms may arise by hybridisation or mutation, the former method being the more common [Stakman, Levine, Cotter and Hines 1934]. Mutations appear to be relatively rare but even a single new mutant may by crossing with the old ones give rise to several new forms. The existence of such a large number of physiologic rust forms and the possibility of new ones arising in the future renders the problem of breeding rust-resistant wheats particularly arduous.

It is heartening, therefore, to find that there are certain hopeful features. These are the discovery (1) that certain varieties which are susceptible in the seedling stage exhibit considerable resistance when mature, *e.g.* Hope, H.-44-24 and Acme [Goulden, Newton and Brown, 1930], (2) that resistance to a number of physiologic forms may be governed by a single factor.

Mature or field resistance, although its exact nature is not yet fully understood, appears to be morphological and Hursh [1924] has shown that the rust mycelium develops almost exclusively in the chlorenchymatous collenchyma of wheat stems and

that in consequence varieties wherein the collenchyma bundles are small and separated by sclerenchymatous fibres, are resistant. On the other hand, varieties with a large development of collenchyma are susceptible. It has also been demonstrated by Hart [1931] that the resistance of a variety may sometimes depend on the time of opening of the stomata. Some varieties showing field resistance are resistant because they open their stomata after the morning dew has dried up ; consequently germinating rust spores are killed before a means of entry is available to them.

Mature plant resistance is general, regardless of the particular forms of rust present, and as such is of very great practical importance. While, in the words of Hayes [1930], " true protoplasmic resistance is perhaps more valuable than morphological resistance because it is less dependent upon environment, there is the possibility that morphological resistance would be less influenced by physiologic forms of the disease organisms than physiological resistance." There is evidence that mature resistance may be inherited in a simple manner, and may combine readily with economically important characters [Goulden, Neatby and Welsh, 1928]. It may be quite independent of seedling resistance [Hayes, Stakman and Aamodt, 1925 ; Goulden, Neatby and Welsh, 1928].

Resistance to more than one physiologic form may be controlled by a single factor. Thus immunity to 11 physiologic forms of black rust in Kanred wheat is governed by a single genetic factor [Aamodt, 1923]. Again, in a cross between Marquis and H.-44-24, Goulden, Neatby and Welsh [1928] found that the factors which controlled reaction to physiologic form 21 were also responsible for reaction to forms 9, 14, 15, 17 and 34. This mode of inheritance makes breeding against rust relatively easier. Certain varieties, however, may possess resistance-inhibiting factors [Goulden and Neatby, 1931]. Another obstacle may arise in that a factor for resistance to a particular form may bring about susceptibility to another form [Goulden, Neatby and Welsh, 1928].

A great deal of the work on the breeding of resistant wheats has been accomplished in North America where the losses due to rusts are particularly heavy. It is not possible here to give an adequate account of the work but some of the outstanding achievements may be briefly mentioned.

As stated in an earlier paragraph, the linkages between species characters and rust-resistance are such as to render difficult the production of the desired recombinations. But by growing very large populations in the F_2 and F_3 generations, plants combining rust resistance with *vulgare* characters have been obtained from crosses between *vulgare* and resistant *durum* and Emmer varieties. Among the outstanding instances are: (1) the production of the variety Marquillo, combining rust resistance with fairly good milling quality and other *vulgare* characters, by crossing the *durum* wheat, Iumillo, with the well-known *vulgare* variety, Marquis [Hayes, Stakman and Aamodt, 1925], (2) the production of the varieties Hope and H.-44-24 by crossing Yaroslav Emmer and Marquis. These two strains are said to be practically immune under field conditions, and although they cannot be regarded as commercial

wheats, they are considered to be very promising for breeding purposes [McFadden, 1925]. (3) The breeding of the Marquis-Pentad hybrid. This was obtained by crossing Marquis and the *durum* variety, Pentad, and while distinctly a *vulgare* type, possesses the field resistance of Pentad [Goulden, 1929].

Coming now to the problem of wheat rusts as it exists in India, Prof. K. C. Mehta's researches [1933] have indicated that the number of physiologic forms of the three rusts in this country is probably not large. Up to now he has obtained only four forms of black rust, two of brown and three of yellow. As, however, none of the indigenous varieties of wheat so far tested is resistant to all the physiologic forms occurring in India and as the few resistant exotic varieties are in all likelihood unsuited for direct cultivation under Indian conditions, it is apparent that hybridisation will have to be resorted to.

A scheme has recently been put up before the Advisory Board of the Imperial Council of Agricultural Research for breeding rust-resistant wheats at the Botanical Section, Pusa and at Simla, in collaboration with Prof. Mehta. The principal method employed will be to cross the best indigenous varieties with resistant foreign ones with the object of combining the agriculturally and economically desirable qualities of the former with the rust resistance of the latter. In the case of the brown and yellow rusts, *vulgare* varieties resistant to the Indian physiologic forms are known and so it is not anticipated that there will be very great difficulty in transferring their resistance to Indian varieties. In the case of black rust the question is much more complex. No wheat, indigenous or exotic, resistant in the greenhouse to all the four forms of this rust occurring in India is known: the greatest resistance is possessed by Khapli, an Emmer wheat, which past experience has shown, does not cross readily with *vulgare* varieties [Waterhouse, 1930]. It may become necessary first to cross it with a *durum* variety, select from the progeny of the cross a resistant *durum* segregate, and then cross the latter with a *vulgare* variety. A more promising method perhaps would be to utilise the mature resistance of certain *vulgare* varieties. It has been remarked before that some varieties which are susceptible in the greenhouse exhibit very considerable resistance in the field. This aspect of the problem is receiving attention and from the practical viewpoint may prove to be more remunerative.

It will not be sufficient to breed wheats resistant only to black or brown or yellow rust: what is required is varieties resistant to all three. To accomplish this, further crossings may be necessary.

It is obvious that the breeding of wheats resistant to the rusts is likely to be neither simple nor very rapid. But the importance of the problem to Indian agriculture demands that every effort shall be made to realize this object as expeditiously and as completely as possible.

Summary

The ultimate solution of the problem of the wheat rusts lies, as in the case of most plant diseases, in the production by the breeder of disease-resistant varieties.

Progress in the breeding of rust-resistant wheats has however been slow because whilst the economically desirable qualities are concentrated in the bread wheats, the greatest measure of rust-resistance is possessed by wheats of the Emmer group and the members of those two groups either fail to cross with each other or cross with some difficulty, segregation in subsequent generations being often extremely complex. The existence of a large number of physiologic forms of rust further complicates the problem : no wheat resistant to all these forms is known.

Encouraging features however exist in that certain varieties which are susceptible in the seedling stage in the greenhouse exhibit very considerable resistance in the adult stage under field conditions, and in that resistance to several physiologic forms may be controlled by a single genetic factor.

The production in North America of varieties combining relatively high rust resistance with *vulgare* characters such as Marquillo, Hope, H.-44-24 and the Marquis Pentad hybrid, by crossing varieties of *Triticum vulgare* with *T. dicoccum* and *T. durum* indicates the possibilities of this method. In India the position appears to be hopeful for Prof. K. C. Mehta's investigations show that the number of physiologic forms of the three rusts occurring in this country is probably not large and a scheme has been drawn up for breeding rust-resistant wheats at Pusa with the collaboration of Prof. Mehta. As, however, none of the indigenous varieties so far tested is resistant to all the Indian forms of rust, and as resistant foreign varieties are unsuited for cultivation under Indian conditions, hybridisation between these will have to be resorted to to achieve this end.

REFERENCES

Aamodt, O. S. (1923). *Jour. Agric. Res.* **24**, 457-69.

———————— (1927). *Jour. Amer. Soc. Agron.* **19**, 206-18.

Goulden, C. H. (1929). *Sci. Agric.* **10**, 258-67.

Goulden, C. H. and Neatby, K. W. (1931). *Jour. Amer. Soc. Agron.* **23**, 859-70.

Goulden, C. H., Neatby, K. W. and Welsh, J. N. (1928). *Phytopath.* **18**, 631-58.

Goulden, C. H., Newton, M. and Brown, A. M. (1930). *Sci. Agric.* **11**, 9-25.

Harrington, J. B. and Aamodt, O. S. (1923). *Jour. Agric. Res.* **24**, 979-996.

Hart, H. (1931). *U. S. Dept. Agr. Tech. Bull. No.* 266, 75 pp.

Hayes, H. K. (1927). *Leopoldina* : 250-62.

———————— (1930). *Amer. Nat.* **64**, 15-36.

Hayes, H. K. and Aamodt, O. S. (1923). *Jour. Agric. Res.* **24**, 997-1012.

Hayes, H. K., Parker, J. N. and Kurtzweil, C. (1920). *Jour. Agric. Res.* **19**, 523-42.

Hayes, H. K. and Stakman, E. C. (1921). *Paper No.* 300, *Jour. Ser., Minn. Agric. Exp. Sta.* 14 pp.

Hayes, H. K., Stakman, E. C. and Aamodt, O. S. (1925). *Phytopath.* **15**, 371-86.

Hursh, C. R. (1924). (*Jour. Agric. Res.* **27**, 381-411.

Mains, E. B. (1926). *Jour. Hered.* **17**, 313-25.

Mcfadden, E. S. (1925). "Synthetic " rust proof wheats. Cited in Goulden (1929).

Mehta, K. C. (1933). *Ind. Jour. Agric. Sci.* **3**, 939-62.

Neatby, K. W. (1931). *Sci. Agric.* **12**, 130-54.

Stakman, E. C., Levine, M. N., Cotter, R. U. and Hines, L. (1934). *Jour. Agric. Res.* **48**, 953-69.

Stakman, E. C. and Piemeisel, F. J. (1917). *Abst. in Phytopath.* **7**, 73.

Straib, W. (1929). *Der Züchter* **1**, 217-23.

Waldron, L. R. (1926). *N. Dakota Agric. Exp. Sta. Bull.* 200 : 64 pp.

Waterhouse, W. L. (1930). *Proc. Linn. Soc. N. S. W.* **55**, 596-635.

APPLICATION OF MODERN STATISTICAL METHODS TO YIELD TRIALS (WOODHOUSE MEMORIAL PRIZE ESSAY, 1933)

BY

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In recent years, the need has been keenly felt in agricultural research for a sound technique to judge aright the yielding capacities of different varieties of a crop. The plant breeder, in the past, had learnt to accord no credence to small differences in yield between varieties observed on a field scale and in his estimation of the relative merits of strains, intuition played no small part. In pioneer work spectacular increments are only worthwhile; but sooner or later a stabilization is reached, when small differences can be none too readily dismissed, for in so doing many improved strains will pass unnoticed just because they had not proved *par excellence*. At that stage the importance of delicate and stringent trials cannot be overestimated. Consequently, much ingenuity has been expended, notably by Fisher and Beaven, in developing those phases of statistical theory so relevant in modern yield trials.

THE PROBLEM

The excellence of the yielding capacity of a variety of crop is the commonest problem of a plant breeder. The problem would have been quite simple, had the conditions controlling growth been identical for every plant of a crop; then the least difference observed can rightly be attributed to some intrinsic quality. But in actual practice, when the same crop is grown on a field made as homogeneous as humanly possible, no two plants yield the same. If then, two equal fields under two varieties yield simultaneously 5,000 and 5,500 lbs. respectively, what legitimate reasons can there be for accepting the difference to be different from that observed, even when the varieties are the same. If there is a past record of ten years, and at no time under the same crop did the second field excel the first by more than 7 per cent, then it is reasonable to conclude that the difference of 10 per cent now observed to be not due entirely to chance; even more is our certainty if such an experience is borne out by a record of a hundred years which is not a particularly convenient period.

In making use of the past record, unconsciously the probabilities of differences are estimated. It will be expedient if that information can be obtained even from a single trial, and this is precisely the achievement of modern statistical methods. For a critical appreciation of these, it is indispensable to grasp a few fundamental statistical concepts. The theoretical implications are accessible only to special students; none the less, the conclusions reached are simple and within the reach of all.

SOME RELEVANT STATISTICAL CONCEPTS

The term "error" so common in statistical parlance is not the same as the error two and one make four. When a series of measurements are made of a fixed quantity with the most meticulous precautions, they all do not agree. The deviations of these observations from the most probable value are called errors. The frequency distribution of these errors follows a type of curve called the normal curve of error. The most probable value of the measured quantity is the arithmetic mean of all the observations; σ^2, the mean of the squares of the errors, is the variance and σ is the standard error. The mean and the variance completely specify a normal distribution.

P is the probability of exceeding an assigned deviation without respect to sign; $P = \cdot 1$ for an error ε is interpreted that an observation with an error numerically greater than ε will occur once in ten trials. "Significance" is another word so frequently used that its purely conventional meaning is not rightly apprehended. Final statements in statistical investigations are made only in terms of P. It has become a practice to consider errors, for which P is more than $\cdot 05$, as due to chance, and when P is less than $\cdot 05$, the deviation deserves attention as arising out of causes not accidental but significant. This is a mere convention; the level of significance is sometimes taken at $\cdot 01$.

In dealing with small samples, the concept of "degrees of freedom" borrowed from the generalised theory of the dynamics of a particle has proved fruitful. In statistics, the number of degrees of freedom is obtained by subtracting from the number of observations the number of parameters calculated from the data, provided the parameters satisfy Fisher's criteria of sufficiency and efficiency. In a small sample, s^2, the best estimate of variance, is obtained by dividing the sum of the squares of the deviations by the degrees of freedom instead of by the total number in the sample. If x is the deviation of a sample mean from the true value in the population, n, the size of the sample $t = \frac{x\sqrt{n}}{s}$ s distributed in a known way. For two samples of size n_1 and n_2, and variance s_1 and s_2 respectively, $z = \log^e \frac{s_1}{s_2}$ for degrees of freedom n_1-1, and n_2-1 follows a known distribution. Furthermore, a variance due to several causes can be resolved into variances due to the respective components. This is the principle of the Analysis of Variance, the keystone to modern yield trials.

THE PROBLEM RESUMED

In the first experiment contemplated, in which two fields yielded 5,000 and 5,500 lbs. respectively, had each of the fields been divided into 100 plots, the mean yield of a plot for the two would have been 50 and 55 lb. respectively; let the standard error per plot be 12 and 14 lb. respectively. Then the standard error of the

difference of the two means would be $\sqrt{\frac{12^2+14^2}{100}} = 1 \cdot 84$ lbs. and for the observed difference of 5 lbs. P is less than $\cdot 01$. Inasmuch as such a judgment relied on the standard error, the solution of the problem of yield trial depends on the estimate of that standard error wherewith the difference between varieties may be made comparable. The simple expedience of replication will secure a valid estimate of error. But there is a complication arising out of the fact, that in yield trials, besides accidental errors, there is the variation due to soil heterogeneity which may be disconcertingly high. In the sequel it will be seen that the success of the method of the analysis of variance lies precisely in the fact that a large portion of the variance due to soil heterogeneity can be separated from that due to error. Meanwhile the conditions under which tests of significance are valid will have to be examined.

On the difference between the plots of like varieties depends an estimate of error. If this is to be applied to compare differences between varieties, it must for validity arise from just those causes which are effective in disturbing the comparisons. Hence, there must be no discretion in the arrangement of plots of like and unlike varieties ; in other words, the arrangement must be thoroughly random.

It seems to appeal to commonsense that a systematic arrangement like the chessboard and other ingenious arrangements, in which like varieties are spread regularly over the whole experimental area, will make the errors of comparison between varieties smaller than in a random arrangement. It may be so. Nevertheless, as the principle of variance makes clear, any adjustment which minimises the real errors of comparison will be followed by an increase in the estimate of error ; a fraction of the variance simply changes place. If the systematic arrangement had actually increased the errors of comparision, the estimate of error would now be diminished. In either case, the test of significance is not valid.

Moreover, the ratio of the real error to the estimated error for each one of all the possible arrangements for a given number of plots is distributed in a manner aforementioned. In order that the test of significance be valid, what is of moment is not that the arrangement must appear to be in disorder, but that it must be arrived at by chance and chance only. The occurrence of a systematic arrangement is also in the scheme, provided it is stumbled upon by accident ; for in all the possible arrangements are also included all the possible systematic arrangements.

Randomised blocks

The foregoing argument shows that the standard error is the touchstone in a yield trial, that an estimate of error is obtained by replication, and that the validity of the estimate is secured by a random distribution of the varieties over the replicated plots. The practical application of these considerations is perfectly straightforward. If, say, five varieties are to be compared and six replications are decided on, the experimental area is partitioned into six compact blocks, and each block is further divided into five plots and assigned to the five varieties at random. This is the Randomised Block arrangement.

Randomisation which was shown to be so insistent seems to be violated now by the restriction that one variety only can appear in a block. Not so ; the validity of the estimate of error will be stringent notwithstanding this restriction, provided this restriction is represented by a suitable entry in the analysis of variance to be presently described. Further, with unrestricted randomisation of plots, the experimental error, though accurately estimated, will be unduly large. With this limitation those components of soil heterogeneity which produce differences in fertility between plots of the same block are completely randomised ; the difference in fertility between different blocks are eliminated from the estimate of error. The whole procedure can be elegantly set forth algebraically when there are m varieties and n replications.

x_{rs} is the yield of the rth variety in the sth block ; $\bar{x}$ the general mean ; a_r the mean per plot of variety r ; b_s the mean per plot in the block s ; and d_{rs} is $x - (a_r + b_s - \bar{x})$. Then $SS\ (x_{rs} - \bar{x})^2 = nS\ (a_r - \bar{x})^2 + mS\ (b_s - \bar{x})^2 + SS\ (d^2_{rs})$.

Blocks	Varieties 1	2 —— r —— m	Means
1 . .	x_{11}	x_{21} —— x_{r1} —— x_{m1}	b_1
2 . . .	x_{12}	x_{22} —— x_{r2} —— x_{m2}	b_2
— . . .	—	—— —— ——	—
— . . .	—	—— —— ——	—
s . . .	x_{1s}	x_{2s} —— x_{rs} —— x_{ms}	b_s
- . . .	—	—— —— ——	—
n . . .	x_{1n}	x_{2n} —— x_{rn} —— x_{mn}	b_n
Means . . .	a_1	a_2 a_r a	$\bar{x}$

The total variation due to the several causes is analysed as under.

Analysis of Variance.

Variation due to	Degrees of Freedom	Sum of Squares	Mean Square
Varieties	$m-1$	$nS\ (a_r - \bar{x})_2$	v^2_a
Blocks	$n-1$	$mS\ (b_s - \bar{x})^2$	v^2_b
Error	$(m-1)(n-1)$	$SS\ (d^2_{rs})$	v^2_e
Total .	$mn-1$	$SS\ (x_{rs} - \bar{x})^2$	

The variances are obtained by dividing the sum of squares by the respective degrees of freedom. It can be shown by a little reasoning, that if only field errors were the disturbing factors in the experiment, the mean variances v_a^2 and v_b^2 measure the same variance as v_e^2. So we test whether v_a and v_b are significantly different from v_e; the z-test serves the purpose. The significance of varietal difference will be proved, if P is less than ·05 (adopting that convention) for $z = \log_e \frac{v_a}{v_e}$ for m-1 and (m-1) (n-1) degrees of freedom. The difference between any two variety means, say a_h and a_i is significant or not according as P is less than, or greater than, ·05 for $t = \frac{a_h - a_i}{v} \sqrt{\frac{n}{2}}$, because the standard error of the difference between two variety means is simply $v_e\sqrt{\frac{2}{n}}$. It must be remembered that even if the difference between two varieties is above the conventional level of significance, it is not conclusive, unless the significance of varietal variation is first established by the z-test.

The effectiveness of the block arrangement is demonstrated by a z-test on v_b^2, the mean variance due to blocks. P must be less than ·05 for $z = \log \frac{v_b}{v_e}$ for n$-$1 and ($m-1$) ($n-1$) degrees of freedom. The variation due to soil heterogeneity is shared between block variance and residual variance. Should the orientation, size and shape of the blocks be such that the mean fertility of each block is distinctly uneven, it will be reflected in a large block variance ; on the other hand, if the mean fertility of each block is nearly constant, the greater share of the soil variation will fall to "residual variation." How much of the soil variation will appear in the one or the other, depends entirely on the interrelation of the plot size with block size, and the type of soil heterogeneity encountered.

As an illustration of the analysis outlined above, consider a test on 6 varieties of a crop, repeated 4 times. The yields derived from the randomised blocks will be entered in a two-fold table.

Blocks	Varieties						Total
	A	B	C	D	E	F	
1 . .	121	175	184	102	150	130	862
2 . .	98	158	180	90	152	120	798
3 . .	130	180	190	120	160	140	920
4 . .	125	170	194	125	165	145	924
Total . .	474	683	748	437	627	535	3504

Analysis of Variance

Variation due to	Degrees of Freedom	Sum of Squares	Mean square	$\frac{1}{2}\log_e$ (Mean square)
Varieties	5	18664	3733	4·1
Blocks	3	1753	584	3·2
Error	15	533	36	1·8
Total .	23	20950		

$1{\cdot}8 = 2{\cdot}3$ for degrees of freedom $n_1 = 5$ and $n_2 = 15$. Fisher's z table for 5 per cent distribution gives $z = {\cdot}53$ for $n_1 = 5$ and $n_2 = 15$. Therefore we conclude that the varietal differences are real. The critical difference for significance for the difference between any two variety totals is $\sqrt{36 \times 4 \times 2} \times 2{\cdot}13 = 34$ (nearly) ($t = 2{\cdot}13$, for $n = 15$ and $P = {\cdot}05$) Hence C$>$ B$>$ E$>$ F$>$ A$>$ D.

The shape of plots

Christidis has shown by theoretical reasoning verified on a large number of uniformity trial data, that whether the soil heterogeneity is patched or gradual, the long and narrow plots are more uniform than square plots, except in the extreme case when the length of the plots is across the direction of a steady fertility gradient Nevertheless, groups of long plots are much more variable in comparison with the ultimate long plots, than are groups of square plots with respect to the unit square plot. In applying the analysis of variance, the sum of squares due to blocks will in the former case, be larger than when the plots are square.

A limited case of block arrangement

Beaven's half-drill-strip method was historically the fore runner of the randomised block arrangement. It derives its name from the circumstance that half the drill carries seed of one variety A, and the other half another variety B ; as the drill goes up and down, the field is sown to the scheme ABBAABBA........ It is also known as "Student's method." The arrangement is none other than a block arrangement for two varieties A and B arranged systematically in each block. If x and y be the yields from the A and the B plots, n the number of blocks constituting AB and BA alternately, $\bar{x}$ an $\bar{y}$ the variety means, then s, the standard error of the mean difference, is $\left\{ \frac{S(x-y)^2}{n(n-1)} - \frac{(\bar{x}-\bar{y})^2}{n-1} \right\}^{\frac{1}{2}}$

and P corresponding to $t = \frac{\bar{x}-\bar{y}}{s}$ for $n-1$ degrees of freedom is readily obtained from tables.

From the point of view of the analysis of variance, overlooking the fact that A and B are systematically arranged in each block, the total variation is resolved as below :—

Variation due to	Degrees of freedom	Sum of squares	Mean variance
Varieties	1	$\frac{(\bar{x}-\bar{y})^2 n}{2}$	v_a^2
Blocks	$n-1$	$\frac{1}{2}S(x+y-\bar{x}-\bar{y})^2$	v_b^2
Error	$n-1$	$\frac{S(x-y)^2-n(\bar{x}-\bar{y})^2}{2}$	v_e^2

It is seen at once that $t = \frac{v_a}{v_e}$. The former test by t for $n-1$ degrees of freedom is equivalent to the test by $z = \frac{1}{2} \log_e t^2$ for 1 and $n-1$ degrees of freedom.

The Latin Square

The problem of the Latin Square, formulated by the mathematician Euler, is the enumeration of all possible arrangements of n elements in a square of n^2 units, so that each element appears once in each row and column. Fisher recognised in this a restricted form of block arrangement when there are as many replications as varieties under trial; forthwith he perceived that with this restriction positional variance can be exploited in two directions. Out of all the possible Latin Square arrangements for a given number of elements, one is chosen at random, and the plots, not necessarily squares, are arranged in that design; the pattern can also be unfolded row by row so that the n^2 plots lie side by side. The two restrictions duly appear in the analysis of variance as variations due to rows and columns. The analysis is as below :—

Variation due to	Degrees of freedom	Sum of squares	Mean square
Rows	$n-1$	$nS\ (b-\bar{x})^2$	v_b^2
Columns	$n-1$	$nS\ (c_t-\bar{x})^2$	v_c^2
Varieties	$n-1$	$nS\ (a_r-\bar{x})^2$	v_a^2
Error	$(n-2)\ (n-1)$	$SS\ (d^2)$	v_e^2

where b_s is the mean per plot in row s, c_t the mean per plot in column t, and a_r the mean per plot of variety r.

Consider five varieties A, B, C, D and E arranged according to the Latin Square plan given below :—

Rows	Columns					Total
1 . .	A 271	C 282	D 267	E 268	B 256	1344
2 . .	B 256	D 288	E 286	A 306	C 282	1418
3 . .	C 276	A 276	B 285	D 293	E 280	1410
4 . .	E 267	B 293	A 280	C 277	D 286	1403
5 . .	D 326	E 321	C 305	B 306	A 285	1543
Total .	1396	1460	1423	1450	1389	7118

Analysis of variance

Variation due to	Degrees of freedom	Sum of squares	Mean square	$\frac{1}{2}\log_e$ (mean square)
Variety	4	425	106	2·3
Rows	4	4246	1062	3·4
Columns	4	796	199	3·7
Error	12	2038	170	2·6
Total .	24	7505		

For $z = 2{\cdot}6 - 2{\cdot}3 = {\cdot}3$, when $n_1 = 12$ and $n_2 = 4$, P is well above ·05. The varietal differences are not significant.

The method of the Latin Square may appear to be vulnerable at one point. It may be argued that sometimes the advantage scored in reducing the sum of squares due to error, by eliminating the variation due to either rows or columns, may be defeated by the loss of degrees of freedom, so that the error variance is actually increased. If it can be predicted that in one direction the component of soil heterogeneity is inappreciable, then the appropriateness of the simpler block arrangement is unquestioned. But since such a prediction is usually not forthcoming, it is logical to adopt the Latin Square method in order that the residual variance on which hangs the precision of the experiment shall not unduly be magnified. When in this way, positional variation is eliminated from the field results, the statistician has no choice but to eliminate them in his estimate of error. If a portion of these is included because it makes the estimate smaller, the essential condition of an unbiassed estimate is violated, and experience shows that the reduction of error variance by this method is exceptional.

Seasonal factor in yield trials

It is a common experience of the plant breeder that a variety which holds no promise in one year, proves excellent in another year. The results of an yield trial are therefore true only for the particular weather complex in which the experiment is carried. It seems desirable then, to repeat the experiment a number of years for making trustworthy inferences. If there are m varieties, n replications each year, and the trial is through p years, then the variations can be easily resolved. Adopt the symbols x_{rst} for the yield of any plot, a_r for the mean per plot of variety r through all the years, c_t for the mean per plot of all varieties in the year t, h_{rt} for the mean per plot of variety r in the year t, k_{st} for the mean per plot in block s in the year t, and $\bar{x}$ the general mean. Then $SSS\,(x_{rst}-\bar{x})^2 = npS\,(a_r-\bar{x})^2 + mnS\,(c_t-\bar{x})^2 + mSS\,(k_{st}-c_t)^2 + nSS\,(h_{rt}-c_t+a_r-\bar{x})^2$

$$+ SSS\,(x_{rst}-k_{st}+h_{rt}-c_t)^2$$

and the analysis of variance is as follows :—

Analysis of variance

Variation due to	Degrees of freedom	Sum of squares	Variance
Varieties	$m-1$	$npS\,(a_r-x)^2$	v_a^2
Seasons	$p-1$	$mnS\,(c_t-\bar{x})^2$	v_c^2
Differential respose . .	$(m-1)\,(p-1)$	$nSS\,(h_{rt}-c_t+a_r-\bar{x})^2$	v_h^2
Blocks	$p\,(n-1)$	$mSS\,(k_{st}-c_t)^2$	v_b^2
Error	$p\,(m-1)\,(n-1)$	$SSS\,(x_{rst}-k_{st}+h_{rt}-c_t)^2$	v_e^2
Total .	$mnp-1$	$SSS\,(x_{rst}-\bar{x})^2$	

v_e^2 will test whether there has been [illegible] differential response of varieties in different seasons and v_h^2 serves to test whether the varieties show a consistent difference in different years.

The algebraic analysis given above can be illustrated by a numerical example.

Consider a varietal trial with 3 varieties and 4 replications carried through 3 years. The yields will be tabulated as below :—

Seasons	Blocks	Varieties $r = 1$,	2,	3	Total
$t = 1$ . .	$s = 1$	14	20	12	46
	2	12	22	11	45
	3	11	18	11	40
	4	15	19	10	44
	Total .	52	79	44	175
2 . .	1	16	15	9	40
	2	17	18	11	46
	3	20	16	13	49
	4	15	14	12	41
	Total .	68	63	45	176
3 . .	1	12	21	14	47
	2	14	19	10	43
	3	15	19	9	43
	4	16	20	11	47
	Total .	57	79	44	180
Total for 3 years .		177	221	133	531

Analysis of variance

Variation due to	Degrees of freedom	Sum of squares	Mean square	$\frac{1}{2}$ loge (mean square)
Varieties	2	323	161·5	2·54
Seasons	2	1	0·5	1·65
Differential response . .	4	75	18·8	1·47
Blocks	9	31	3·3	0·60
Error	18	47	2·6	0·48
Total .	35	477		

There has been a significant differential response due to season. For, $z = 1{\cdot}47 - {\cdot}48 = {\cdot}99$ is well above the ·05 level of significance. It is also observed that there is a significant difference between the varieties through the 3 years. This conclusion is reached by comparing the varietal variance with the variance due to differential response. $z = 1{\cdot}07$ is above the ·05 level of significance.

Conclusion

The statistician thinks that the agriculturist has justified the analysis of variance as a fruitful method in yield trials, and the agriculturist thinks that the principle of the analysis of variance is proved by the statistician to be logically precise. Both are perfectly right.

AN IMPROVED INSTRUMENT FOR TESTING RINDHARDNESS IN SUGARCANES

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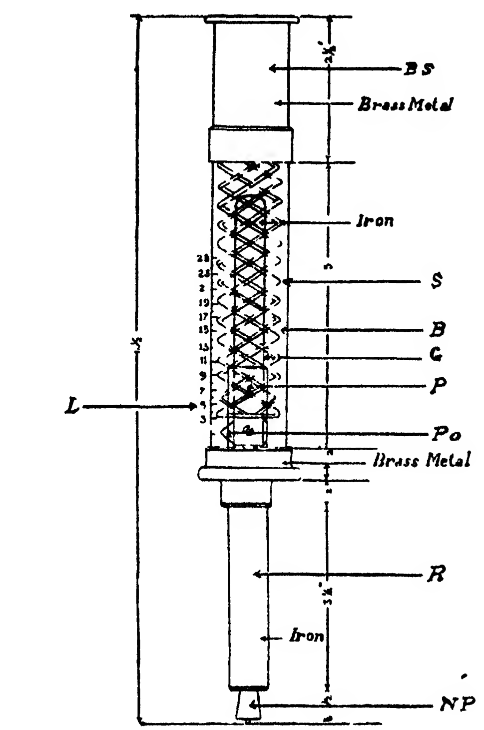
While working at the Imperial Sugarcane Station, Coimbatore, in 1929, the author had to deal with a very large population of seedlings to test their rindhardness with a view to selecting those which were hard enough to resist the attacks of small animals, like rats, porcupines, etc. The instrument used for the purpose was one designed by Puri and Venkatraman [1928] This consisted essentially of a plunger to the upper end of which a circular plate was firmly attached to carry weights. This plunger worked in a close-fitting tube open at both ends, the tube being supported on three legs. The plunger carried at its lower free end the needle point very much like the one hereinafter described in the present instrument. The cane to be tested was placed on the iron-base plate under the needle point and weights slowly added on the disc plate till the cane rind was pierced. The weight in lbs. required indicated the comparative hardness of the rind. During the progress of this work the necessity of lifting the disc plate every time weights were added or replaced and then slowly bringing it down to rest on the portion of the cane stalk below, was found to cause considerable inconvenience. On quite a few occasions the thumb supporting this disc plate suffered injury. An improvement was effected by the author in 1932, by the addition to this instrument of a lever arrangement to lift the disc plate. This made the work comparatively easy and less tiring ; it also enabled the labourer previously required to support the cane below the needle point to be dispensed with. During the course of further work, it became necessary to determine rindhardness in growing canes in the field at different stages of their growth and neither of the above instruments mentioned proved suitable for this purpose. The improved instrument now described (Plate XV) was therefore designed and has proved very useful in this investigation as also in studies on cohesion and penetrability of soils.

New instrument described

The new instrument (Fig. 1) is constructed on the principle of the presometer and consists of a measured capacity spring (S) encased in a cylinderical barrel (B). The spring rests on a piston point (P) which has an extended rod (R) with a hole at its free end to hold the needle point (NP). A groove (G) has been cut in the barrel to permit of movement of pointer (PO) which has been fixed to the piston and indicates the pressure exerted. The scale (pressure in lbs.) has been calibrated by determining the weight in pounds required to press the spring from one calibrated point to another. Brass socket (BS) has been grooved on to the barrel to provide space for the spring and to serve as a handle. To test the rindhardness in the field, the needle point is pressed against the cane stalk (Plate XV) till it breaks through the rind when the reading on the scale records the comparative rindhardness. It

Determining rindhardness of sugarcanes in the field.

may be emphasised that the needle point should be of exactly the same diameter throughout the course of investigation on rindhardness in sugarcanes. The diameter of the piercing points used at the Sugarcane Research Station, Bihar and Orissa, is 0·75 mm. The calibration should of course be checked periodically.



New Rind Hardness Apparatus
Designed at the Sugarcane Research Station B & O

Fig 1

BS = Brass socket for spring
S = Measured capacity spring
B = Barrel
P = Piston point
PO = Pointer to indicate rindhardness
R = Iron rod bearing circular hole to hold needle point
NP = Needle point used for test
L = Scale in lbs.
G = Groove cut in the barrel to permit of movement of pointer.

ACKNOWLEDGMENT

The author is grateful to Messrs. Arthur Butler and Company, Muzaffarpur, for making the instrument in their workshops during the various stages of its development.

REFERENCE

Puri, A. N. and Venkatraman, T. S. (1928). *Proc. of the 1929 Convention of Sugar Technol. Assoc., India.*

POULTRY HOUSING

BY

E. J. BRUEN,

Live-Stock Expert to the Government of Bombay, Poona

Poultry-keeping or farming has been conducted for many gen ıations in India, and to this day you will find many people who have been in this business merely as fanciers or who have tried to make it a commercial business, say that good poultry do not do in India. But few, if any, have taken the trouble to ascertain the reason of such failures.

It is an authentic fact that India is the original home of poultry. The Galus Bankiva or Indian jungle fowl is the original fowl from which our domesticated fowl of to-day have come. This being the case, it is not the environment or the country that is to blame. It is the methods we apply in domestication that are at fault. When we consider that a fowl lays eggs to the extent of nearly 100 times its body weight in eggs in a short space of three years, we can imagine what a strain and drain on the system this must be.

There is no doubt that next to feeding correctly, correct housing is essential if we wish to get the best out of poultry.

The chief enemy of poultry in India is body vermin. These vermin thrive in dark and badly ventilated rooms, such housing must be avoided. In cold countries where the tick is not such a terror to poultry keepers wood is employed in housing. Wood, however, is not suitable in India where the tick abounds ; cracks and joints in wood offer good hiding and breeding places for all forms of body vermin. Wood in all forms should be avoided. Iron and asbestos offer the best material from which to make poultry houses. The initial outlay is slightly larger but they will last a life time, can be taken to pieces and disinfected as often as we feel inclined to do so.

Shape and size of a house plays a big part in economy. Plans and estimates are given of different types of houses necessary on a poultry farm from the brooder for chickens to flock houses.

In rearing chickens successfully, it has been found that wire floors in houses are most essential. These wire floors allow all droppings to pass through, thus keeping the floor clean and no opportunity is given to the young chickens to eat anything it should not eat.

Of particular interest in the plans given is a chicken slatted side with wire floor cage, these cages are intended to house chickens almost from the day they are born until they are ready to go into your flock.

A plan and estimate is given of a cement house; this type of house is very useful for a trio or for testing pens. It will be found in all or most of the houses shown that three sides are open and one side blocked in, this blocked in side should face the prevailing wind.

Another point to remember when planning your poultry farm is to keep your houses and runs away from large trees, such trees give shade it is true, but at the same time they offer good resting places for crows and other birds. It has been ascertained that those poultry keepers who make use of such trees for shade are the first to get disease. Crows and birds carry disease. An open piece of land is the best. Make your own shade by growing plants or bushes, such as, the lemon, orange or other such plants, whose height will not go over your own fencing or wire runs.

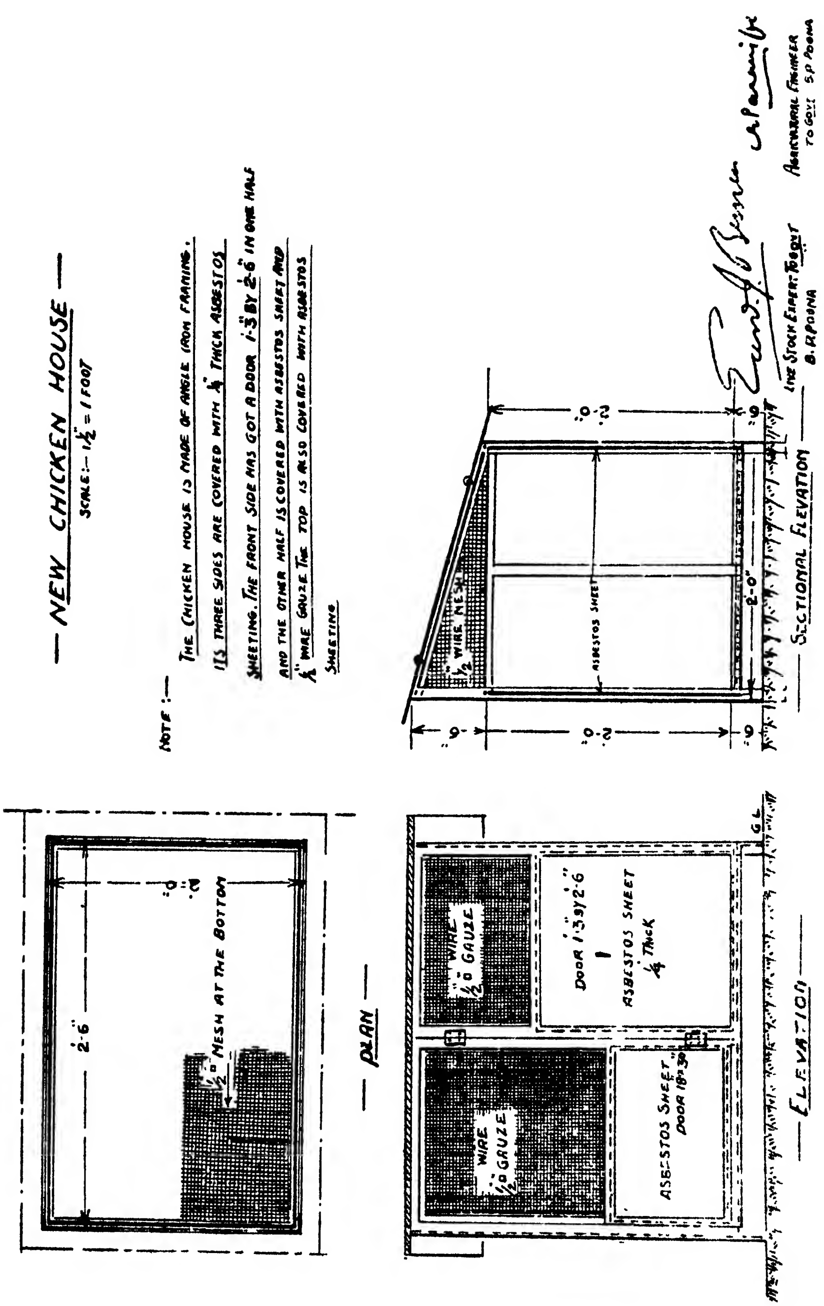

NEW CHICKEN HOUSE
SCALE:- 1½" = 1 FOOT
NOTE :-
THE CHICKEN HOUSE IS MADE OF ANGLE IRON FRAMING. ITS THREE SIDES ARE COVERED WITH ¼" THICK ASBESTOS SHEETING. THE FRONT SIDE HAS GOT A DOOR 1'-3" BY 2'-6" IN ONE HALF AND THE OTHER HALF IS COVERED WITH ASBESTOS SHEET AND ½" WIRE GAUZE. THE TOP IS ALSO COVERED WITH ASBESTOS SHEETING
PLAN
½" MESH AT THE BOTTOM
2'-6"
2'-0"
ELEVATION
WIRE ½" GAUZE
DOOR 1'-3" BY 2'-6"
ASBESTOS SHEET ¼" THICK
ASBESTOS SHEET DOOR 18"x30"
G L
SECTIONAL ELEVATION
½" WIRE MESH
ASBESTOS SHEET
2'-0"
6"
LIVE STOCK EXPERT TO GOVT B.P. POONA
AGRICULTURAL ENGINEER TO GOVT S.P. POONA

Fig 1

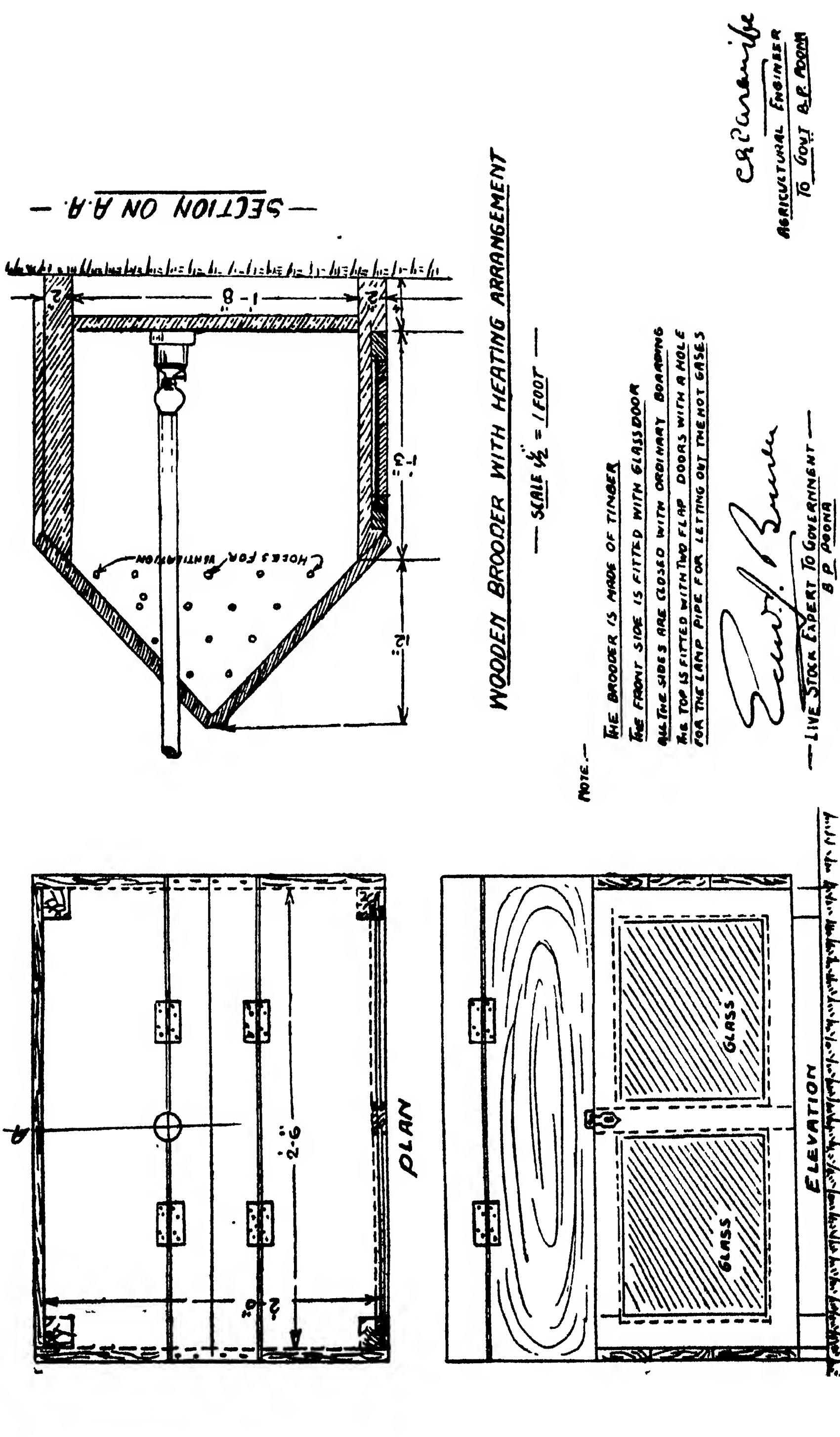

SECTION ON A.A.
HOLES FOR VENTILATION
WOODEN BROODER WITH HEATING ARRANGEMENT
SCALE 1½" = 1 FOOT
NOTE.—
THE BROODER IS MADE OF TIMBER
THE FRONT SIDE IS FITTED WITH GLASS DOOR
ALL THE SIDES ARE CLOSED WITH ORDINARY BOARDING
THE TOP IS FITTED WITH TWO FLAP DOORS WITH A HOLE FOR THE LAMP PIPE FOR LETTING OUT THE HOT GASES
LIVE STOCK EXPERT TO GOVERNMENT B.P. POONA
AGRICULTURAL ENGINEER TO GOVT B.P. POONA
PLAN
ELEVATION
GLASS
GLASS

Fig. 2

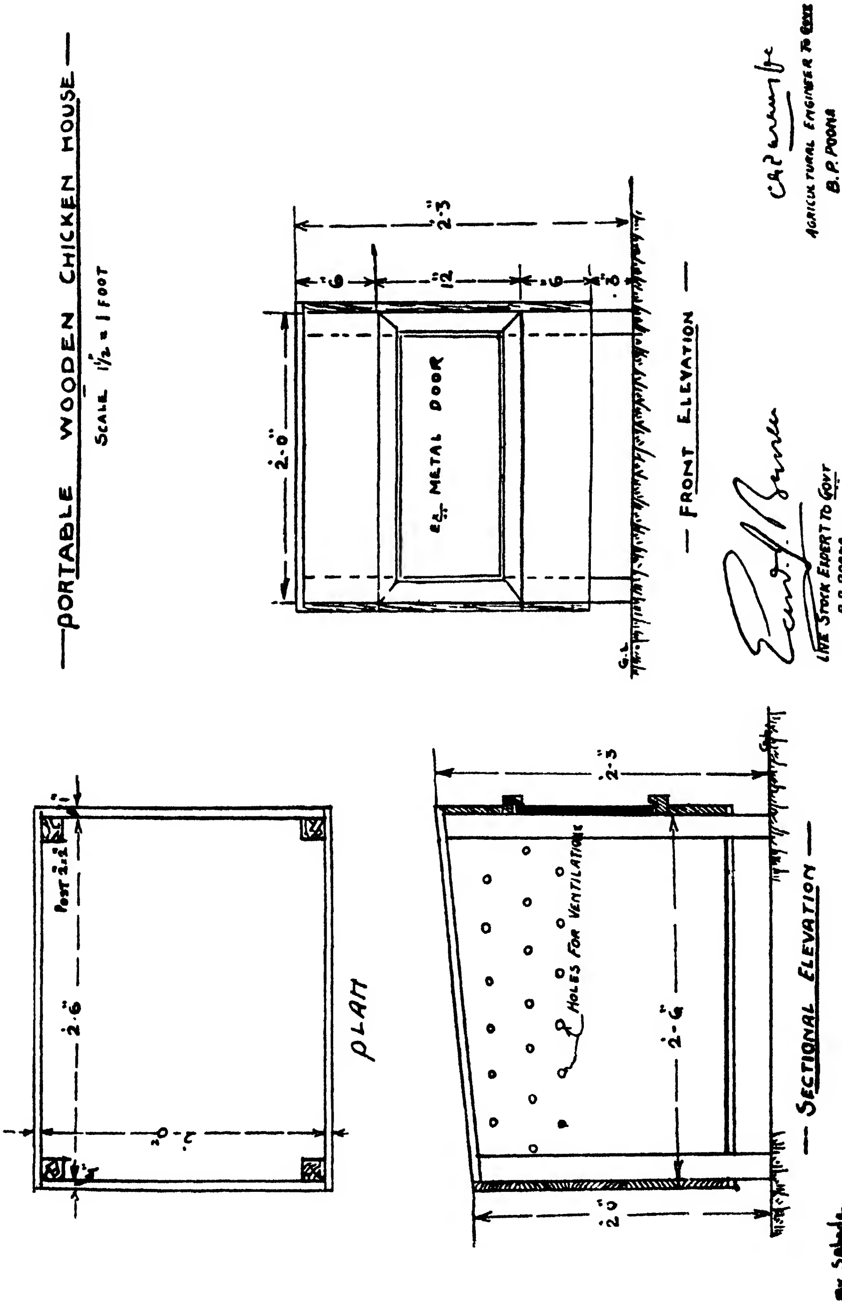

PORTABLE WOODEN CHICKEN HOUSE
SCALE 1½" = 1 FOOT
E.I. METAL DOOR
FRONT ELEVATION
G.L.
PLAN
POST 2×2
HOLES FOR VENTILATION
SECTIONAL ELEVATION
AGRICULTURAL ENGINEER TO GOVT
B.P. POONA
LIVE STOCK EXPERT TO GOVT
B P POONA

Fig. 3

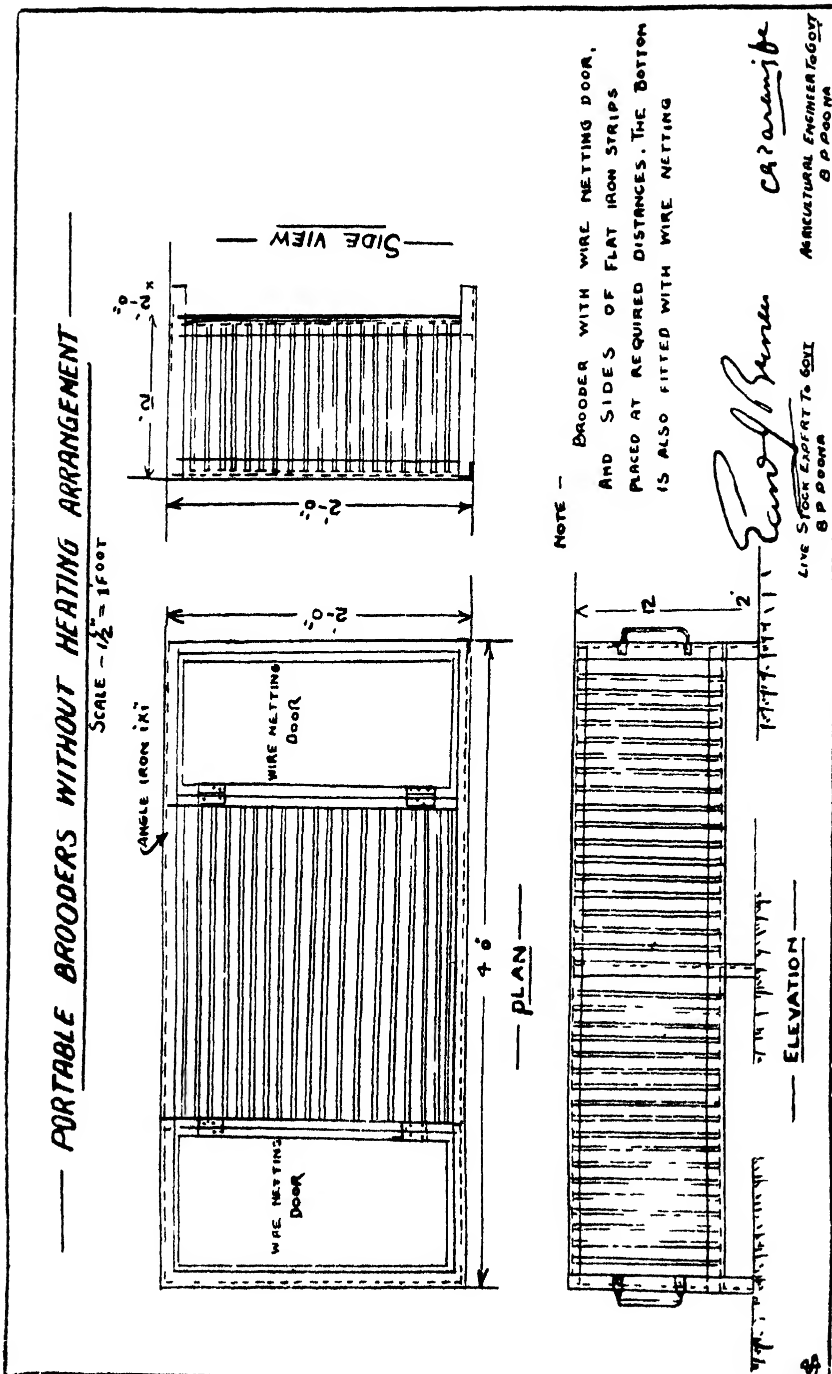
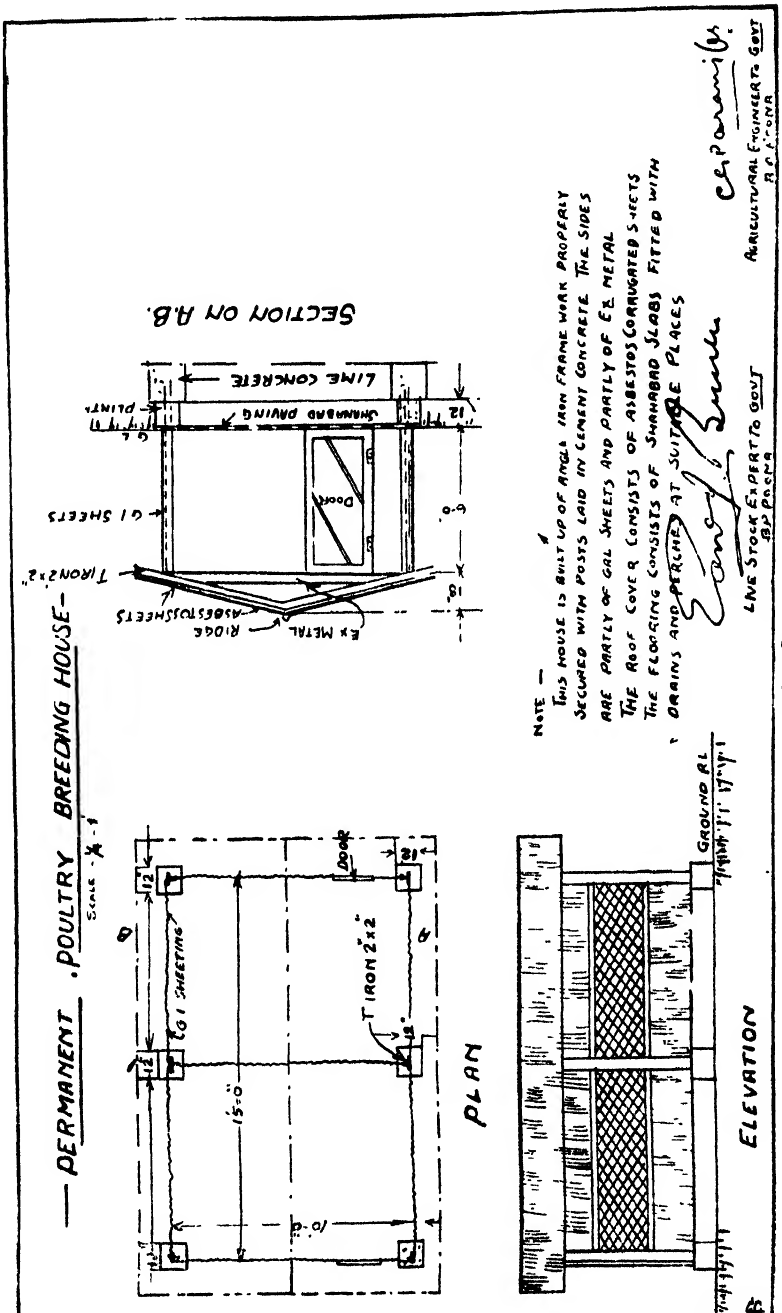

PORTABLE BROODERS WITHOUT HEATING ARRANGEMENT
SCALE - 1½" = 1 FOOT
SIDE VIEW
2'-0"
ANGLE IRON 1x1
WIRE NETTING DOOR
WIRE NETTING DOOR
4'0"
PLAN
ELEVATION
NOTE - BROODER WITH WIRE NETTING DOOR, AND SIDES OF FLAT IRON STRIPS PLACED AT REQUIRED DISTANCES. THE BOTTOM IS ALSO FITTED WITH WIRE NETTING
LIVE STOCK EXPERT TO GOVT B P POONA
AGRICULTURAL ENGINEER TO GOVT B P POONA

Fig. 4



— PERMANENT . POULTRY BREEDING HOUSE —
SECTION ON A.B.
LIME CONCRETE
SHAHABAD PAVING
PLINTH
G L
12"
GI SHEETS
T IRON 2"x2"
ASBESTOS SHEETS
RIDGE
EX METAL
DOOR
6'-0"
1'8"
PLAN
GI SHEETING
T IRON 2"x2"
15'-0"
10'-0"
DOOR
12"
18"
ELEVATION
GROUND RL
NOTE —
THIS HOUSE IS BUILT UP OF ANGLE IRON FRAME WORK PROPERLY SECURED WITH POSTS LAID IN CEMENT CONCRETE. THE SIDES ARE PARTLY OF GAL SHEETS AND PARTLY OF EX METAL
THE ROOF COVER CONSISTS OF ASBESTOS CORRUGATED SHEETS
THE FLOORING CONSISTS OF SHAHABAD SLABS FITTED WITH DRAINS AND PERCHES AT SUITABLE PLACES
LIVE STOCK EXPERT TO GOVT BP POONA
AGRICULTURAL ENGINEER TO GOVT BP POONA

Fig. 5

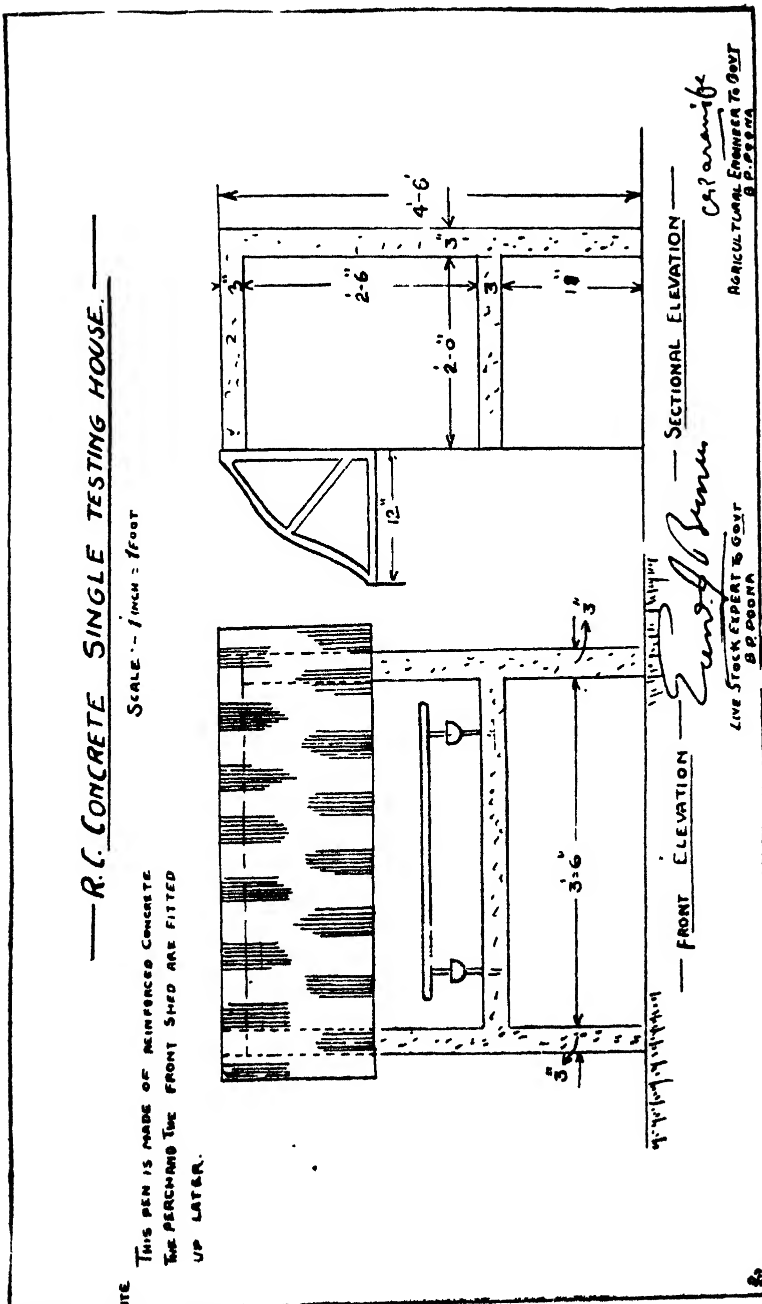

R.C. CONCRETE SINGLE TESTING HOUSE.
SCALE :- 1 INCH : 1 FOOT
NOTE
THIS PEN IS MADE OF REINFORCED CONCRETE
THE PERCHING THE FRONT SHED ARE FITTED
UP LATER.
4'-6"
3"
2'-6"
3"
18"
2'-0"
12"
3"
3'-6"
3"
FRONT ELEVATION
SECTIONAL ELEVATION
LIVE STOCK EXPERT TO GOVT
B.P. POONA
AGRICULTURAL ENGINEER TO GOVT
B.P. POONA

Fig. 6

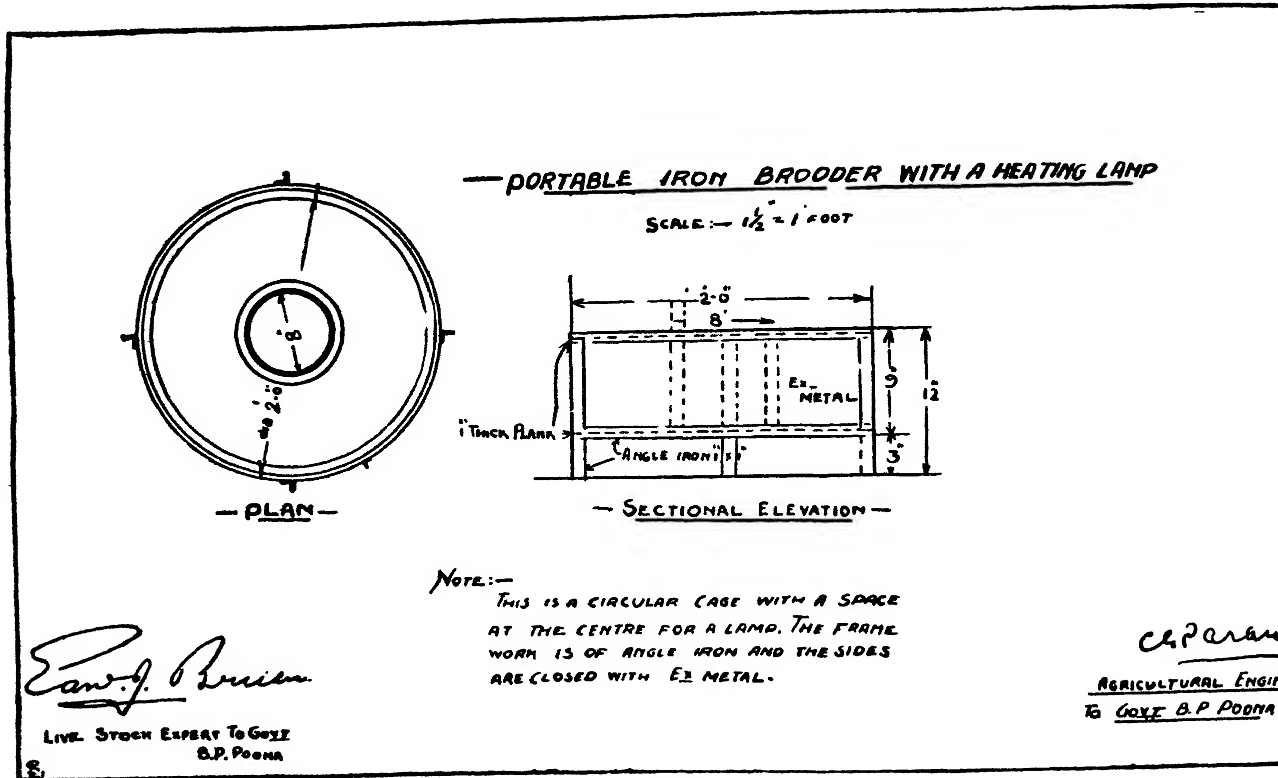

—PORTABLE IRON BROODER WITH A HEATING LAMP
SCALE:— 1½" = 1 FOOT
—PLAN—
8"
2'-0"
2'-0"
8"
9"
12"
3"
EX METAL
1" THICK PLANK
ANGLE IRON 1"x1"
— SECTIONAL ELEVATION —
NOTE:—
THIS IS A CIRCULAR CAGE WITH A SPACE AT THE CENTRE FOR A LAMP. THE FRAME WORK IS OF ANGLE IRON AND THE SIDES ARE CLOSED WITH EX METAL.
LIVE STOCK EXPERT TO GOVT B.P. POONA
AGRICULTURAL ENGINEER TO GOVT B.P POONA

Fig. 7

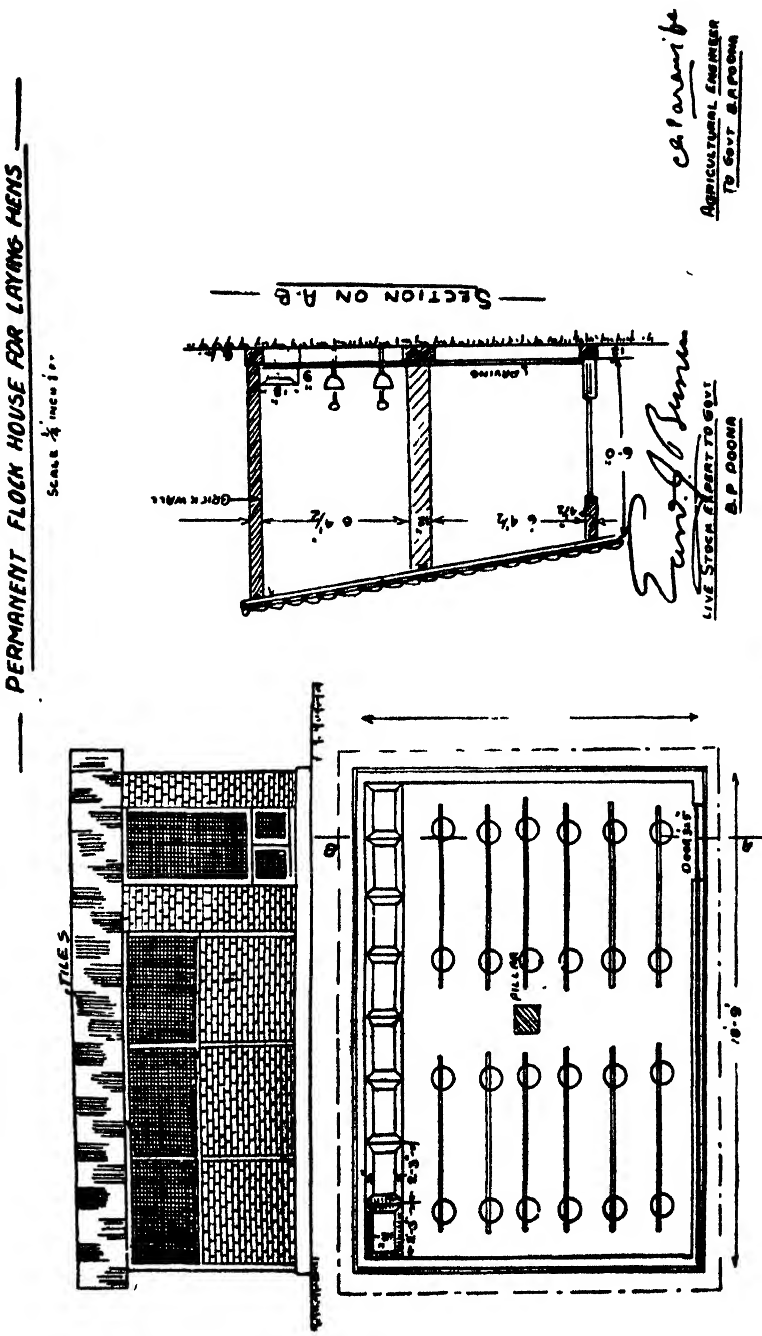

PERMANENT FLOCK HOUSE FOR LAYING HENS
SECTION ON A.B
BRICK WALL
TILES
PILLAR
AGRICULTURAL ENGINEER TO GOVT B.P. POONA
LIVE STOCK EXPERT TO GOVT B.P. POONA

Fig. 8

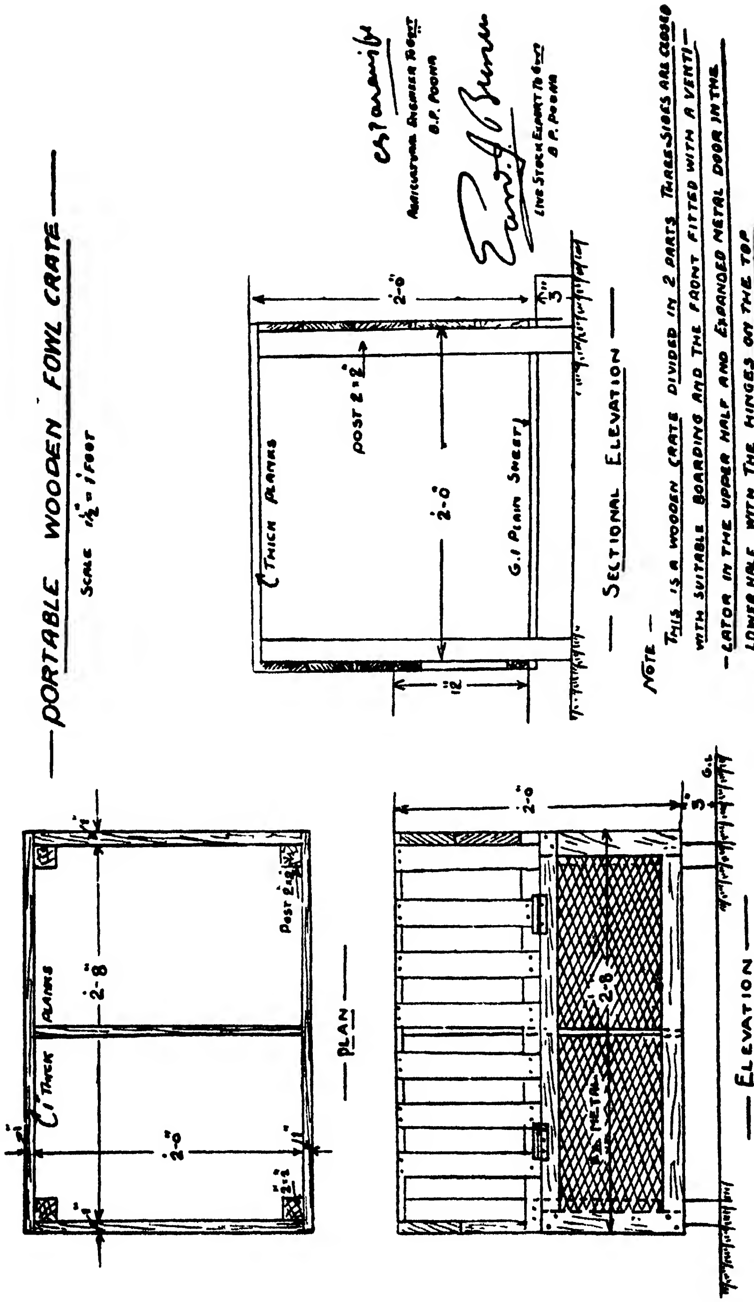

PORTABLE WOODEN FOWL CRATE
SCALE 1½" = 1 FOOT
1" THICK PLANKS
POST 2"×2"
2'-0"
2'-8"
PLAN
EX. METAL
3"
G.L.
ELEVATION
1" THICK PLANKS
POST 2"×2"
G.I. PLAIN SHEET
12"
SECTIONAL ELEVATION
AGRICULTURAL ENGINEER TO GOVT. B.P. POONA
LIVE STOCK EXPERT TO GOVT. B.P. POONA
NOTE — THIS IS A WOODEN CRATE DIVIDED IN 2 PARTS. THREE SIDES ARE CLOSED WITH SUITABLE BOARDING AND THE FRONT FITTED WITH A VENTILATOR IN THE UPPER HALF AND EXPANDED METAL DOOR IN THE LOWER HALF WITH THE HINGES ON THE TOP

Fig. 9

COST OF CONSTRUCTION OF THE POULTRY HOUSES

1.—New chicken house

Quantity	Items	Rate	Amount
		Rs. As. P.	Rs. As. P.
38 lbs.	1 in. angle iron frame work	10 0 0 per cwt.	3 6 0
7·5 lbs.	1 in. × 1/8 in. flat iron	9 0 0 „	0 10 0
23.62 sq. ft.	½ in. thick asbestos sheeting	0 6 0 per sq. ft.	8 14 0
10 sq. ft.	Wire netting ½ in. mesh	30 0 0 per roll	2 0 0
	Sundries	Lump	1 8 0
	Labour	..	3 0 0
	Supervision charges	„	0 10 0
	Total cost		20 0 0

2.—Wooden brooder with heating arrangement

Quantity	Items	Rate	Amount
0·34 c. ft.	(1+4) teak wood	5 0 0 per c. ft.	1 10 0
52·5 r. ft.	Deal wood planks	12 8 0 per 100 r. ft.	6 9 0
2 numbers	Glasses	Lump	1 0 0
1 number	Heating lamp with flue pipe	„	2 0 0
	Sundries	„	1 1 0
	Labour	„	2 4 0
	Supervision charges	„	0 8 0
	Total cost		15 0 0

3.—Portable wooden chicken house

Quantity	Items	Rate	Amount
0·425 c. ft.	(1+2+6) Teak wood posts and doors	5 0 0 per c. ft.	2 2 0
57 r. ft.	(3+4+5) Deal wood planks	12 8 0 per 100 r. ft.	7 2 0
2 sq. ft.	Expanded metal, ½ in. mesh	0 3 0 per sq. ft.	0 6 0
	Sundries	Lump	1 2 0
	Labour	„	2 0 0
	Supervision	„	0 8 0
	Total cost		13 4 0

4.—Portable brooders without heating arrangement

Quantity	Items	Rate	Amount
		Rs. as. p.	Rs. as. p.
229·6 lbs.	(1+2+3+4) 1 in. angle iron frame work . . .	10 0 0 per cwt.	20 8 0
128 lbs.	1 in. flat bar (5+6+7) . .	9 4 0 ,,	10 0 0
4 sq. ft.	Wire netting for doors . .	0 3 0 per s. ft.	0 12 0
	Sundries	Lump	3 4 0
	Labour	,,	3 0 0
	Supervision charges . .	,,	1 8 0
	Total cost . .		39 0 0

5.—Permanent poultry breeding house

Quantity	Items	Rate	Amount
33·75 c. ft.	Excavation for posts . .	1 0 0 per 100 c. ft.	0 6 0
26·25 c. ft.	Filling with lime concrete for posts	25 0 0 ,,	6 9 0
50 c. ft.	Raising plinth stone in mud .	25 0 0 ,,	12 8 0
150 c. ft.	Filling with murum . . .	3 0 0 ,,	4 8 0
150 sq. ft.	1 in. Shahabad paving with cement pointing . . .	24 0 0 per100 sq. ft.	36 0 0
168 lbs.	1½ in. 'T' iron posts . .	10 0 0 per cwt.	15 0 0
465·6 lbs.	1 in. angle iron for frame work .	10 0 0 ,,	41 8 0
75 sq. ft.	Expanded metal ½ in. mesh .	0 3 0 per sq. ft.	14 1 0
23 Nos.	Corrugated iron sheets 8 ft. numbers 8 and 6 ft. numbers 15 (weight 5 cwt.) . .	13 0 0 per cwt.	65 0 0
252 sq. ft.	Corrugated asbestos sheets for roofs	0 6 0 per sq. ft.	94 8 0
18 r. ft.	Corrugated asbestos ridging .	1 0 0 per r. ft.	18 0 0
4 Nos.	Perches and drains . . .	Lump	10 0 0
	Sundries	,,	32 0 0
	Labour	,,	32 0 0
	Supervision charges . . .	,,	16 0 0
	Total cost . .		398 0 0

6.—R. C. concrete single testing house

Quantity	Items	Rate	Amount
		Rs. As. P.	Rs. As. P.
12·5 c. ft.	R. C. concrete 1½in. broken metal	1 8 0 per c.ft.	18 12 0
9·8 lbs.	1 in. angle iron frame . .	10 0 0 ,, cwt.	0 14 0
8 sq.ft.	Plain sheeting	0 3 0 ,, sq.ft.	1 8 0
1 No.	Perch	Lump	3 6 0
	Sundries	,,	2 4 0
	Supervision charges . .	,,	1 0 0
	Labour	,,	2 4 0
	Total cost .		30 0 0

7.—Portable iron brooder with a heating lamp

Quantity	Items	Rate	Amount
13·6 lbs.	1 in. angle iron for posts, etc. .	10 0 0 per cwt.	1 4 0
4·12 sq. ft.	Expanded metal, ½ in. mesh .	0 3 0 ,, sq. ft.	0 13 0
13 r. ft.	Deal wood planks . . .	12 8 0 ,, 100 r. ft.	1 10 0
	Sundries	Lump	1 5 0
	Labour	,,	2 8 0
	Supervision charges . . .	,,	0 8 0
	Total cost .		8 0 0

N.B.—Without the cost of lamp.

8.—Permanent flock house for laying hens

Quantity	Items	Rate		Amount
		Rs. As. P.		Rs. As. P.
51 c. ft.	Excavation in soil . . .	1 0 0	per 100 c. ft.	0 8 0
102 c. ft.	Filling with stone in mud . .	20 0 0	,,	20 0 0
59·5 c. ft.	Murum filling	3 0 0	,,	1 13 0
240 sq. ft.	1 in. Shahabad paving with lime pointing	25 0 0	per 100 sq. ft.	60 0 0
127·11 c. ft.	Brick masonry in lime . .	50 0 0	per 100 c. ft.	64 0 0
7 c. ft.	R. C. concrete posts . .	1 8 0	per c.ft.	10 8 0
20 sq. ft.	Doors	1 12 0	,, sq.ft.	35 0 0
13 sq. ft.	Expanded metal, ½in. mesh .	0 3 0	,,	2 7 0
21 c. ft.	R. C. C. block for water arrangements	100 0 0	per 100 c. ft.	21 0 0
12 Nos.	Perches	3 0 0	each	36 0 0
376·25 sq. ft.	G. I. sheets for roof . .	30 0 0	per 100 sq. ft.	112 14 0
376·25 sq. ft.	Mangalore tile roof . .	32 0 0	,,	120 6 0
23 c. ft.	Cut teak wood for posts, etc. .	5 0 0	per c. ft	115 0 0
	Sundries	Lump		59 0 0
	Labour	,,		59 0 0
	Supervision charges . . .	,,		28 8 0
	Total cost .			746 0 0

9.—Portable wooden fowl crate

Quantity	Items	Rate		Amount
·375 c. ft.	Teak wood posts, etc., (1+5) .	4 0 0	per c. ft.	1 6 0
70 r. ft.	Deal wood plank . . .	12 8 0	per 100 r. ft.	8 12 0
3 sq. ft.	Expanded metal, 1½ in. mesh .	0 3 0	per sq. ft.	0 9 0
	Sundries	Lump		1 5 0
	Labour	,,		2 8 0
	Supervision charges . . .	,,		0 8 0
	Total cost .			15 0 0

MEASUREMENTS OF THE POULTRY HOUSES

1.—New chicken house

	No.	Length	Breadth	Depth	Quantity (decim.)
1 in. × 1 in. × 1/8 in. M. S. angle iron posts	2	2 ft. 6 in.	1 in.	..	4 lbs.
Ditto ditto ditto .	2	3 ft.	1 in.	..	4·8 ,,
1 in. 1 in. × 1/8 in. M. S. angle bottom long	2	2 ft. 6 in.	1 in.	..	4 ,,
1 in. × 1 in. 1/8 in. M. S. angle bottom short . . .	2	2 ft.	1 in.	..	3·2 ,,
1 in. × 1 in. × 1/8 in. M. S. angle top long	2	2 ft. 6 in.	1 in.	..	4 ,,
1 in. × 1 in. × 1/8 in. M. S. angle top short	2	2 ft.	1 in.	..	3.2 ,,
1 in. × 1 in. × 1/8 in. M. S. angle door frame	1	9 ft.	1 in.	..	7.2 ,,
1 in. × 1 in. × 1/8 in. M. S. angle roof for top	3	2 ft. 6 in.	1 in.	..	7.6 ,,
Flat iron—1 in. × 1/8 in. . .	1	18 ft.	1 in.	..	7.5 ,,
¼ in. asbestos sheets for sides .	2	2 ft.	2 ft.	..	8 sq. ft.
¼ in. asbestos sheets for front .	1	2 ft. 6 in.	1 ft. 3 in.	..	3.12 sq. ft.
¼ in. asbestos sheets for back .	1	2 ft. 6 in.	2 ft.	..	5 sq. ft.
¼ in. asbestos sheets for top .	1	2 ft. 6 in.	3 ft.	..	7.5 sq. ft.
¼ in. mesh wire netting . . .	2	2 ft. 6 in.	2 ft.	..	10 sq. ft.
Sundries, labour, and fitting charges			Lump		

2.—Wooden brooder with heating arrangement

Teak wood posts	4	2 in.	2 in.	1ft. 6in	16 c. ft.
Deal wood planks for top, back and bottom	9	2 ft. 6 in.	6 in.	1 in.	22 ft. 6 in. r. ft.
Deal wood planks for sides . .	12	2 ft. 6 in.	6 in.	1 in.	30 r. ft.
Teak wood frame for doors . .	1	3 in	½ in	12 ft.	.187 c. ft.
Two glasses for front door . .	2		Lump		
Heating lamp with flue pipe .	1		Lump		

	No.	Length	Breadth	Depth	Quantity (decim.)
3.—Portable wooden chicken house					
Front teak wood posts . .	2	2 in.	2 in.	2ft. 3 in.	0.125 c. ft.
Back teak wood posts . . .	2	2 in.	2 in.	2 ft.	0.12 c. ft.
Bottom and top deal wood planks	10	1 in.	6 in.	2 ft. 6 in.	25 r. ft.
Sides and top deal wood planks .	8	1 in.	6 in.	2 ft. 6 in.	20 r. ft.
Front and back deal wood planks	6	1 in.	6 in.	2 ft.	12 r. ft.
Frame work teak wood . .	1	3 in.	½ in.	10 ft.	0.18 c. ft.
Expanded metal ½ in. mesh . .	1	2 ft.	1 ft.	..	2 sq. ft.
4.—Portable brooders without heating arrangement					
1 in. angle iron posts . . .	6	12 ft. 2 in.	73 ft.	..	229·6 lbs.
1 in. angle iron sides . . .	8	24 ft.	192 ft.	..	
1 in. angle iron bottom . .	1	2 ft.	2 ft.	..	
1 in. angle iron top . . .	1	10 ft.	10 ft.	..	
1 in. flat bar sides . . .	4	120 ft.	1 ft.	..	480 ft. } 128 lbs.
1 in. flat bar top . . .	1	20 ft.	2 ft.	..	40 ft.
1 in. flat bar bottom . . .	1	20 ft.	4 ft.	..	80 ft.
					600 r.ft.
Wire netting for doors .	2	2 ft.	1 ft.	..	2 sq. ft.
5.—Permanent poultry breeding house					
Excavation for posts . . .	6	1 ft. 6 in.	1 ft. 6 in.	2 ft. 6 in.	33·75 c. ft.
Filling with lime concrete for posts	6	1 ft. 6 in.	1 ft. 6 in.	1 ft. 6 in.	20·25 c. ft.
Ditto ditto ditto .	6	1 ft.	1 ft.	1 ft.	6 c. ft.
Raising plinth stone in mud long walls	2	16 ft.	1 ft.	1 ft.	32 c. ft.
Raising plinth stone in short walls	2	9 ft.	1 ft.	1 ft.	18 c. ft.

	No.	Length	Breadth	Depth	Quantity (decim.)
5.—Permanent poultry breeding house—contd.					
Filling with murum	1	15 ft.	10 ft.	1 ft.	150 c. ft.
1 in. Shahabad paving with cement pointing	1	15 ft.	10 ft.	..	150 sq. ft.
1¼ in. 'T' iron posts	10	7 ft.	1¼ in.	..	168 lbs.
1 in. angle iron for rafter . .	6	7 ft.	1 in.	..	} 465·6 lbs.
1 in. angle iron for purlins . .	4	18 ft.	1 in.	..	
1 in. angle iron door frame . . .	2	34 ft.	1 in.	..	
1 in. angle iron horizontal for all sides, ...	4	100 ft.	1 in.	..	
Expanded metal ½ in. mesh for sides	2	15 ft.	2 ft.	..	60 sq. ft.
Expanded metal for gables . .	2	10 ft × 1·5 ft.	..	..	15 sq. ft.
		2			75 sq. ft.
Corrugated iron sheets for sides long	2	8 ft. × No. 4	..	..	No. 8.
Corrugated iron sheets for short sides	2	6 ft. × No. 5	..	..	No. 10.
Corrugated iron sheets for partition	1	6 ft. × No. 5	..	..	No. 5.
Asbestos sheeting for roof . .	1	18 ft.	14 ft.	..	252 sq. ft.
Asbestos sheeting for ridging .	1	18 ft.	..	..	18 r. ft.
Perches and drains			Lump		
6.—R. C. concrete single testing house					
Back	1	4·5 ft.	4 ft.	·25 ft.	4·5 c. ft. }
Sides	2	4·5 ft.	2 ft.	·25 ft.	4·5 c. ft. } 12·5 c. ft.
Partition and top . . .	2	3·5 ft.	2 ft.	·25 ft.	3·5 c. ft. }
1 in. angle iron frame . . .	2	6 ft.	..	..	9·8 lbs.
Plain sheets.	1	5 ft.	1·5 ft.	..	7·5 sq. ft.
Perch.	1		Lump		

	No.	Length	Breadth	Depth	Quantity (decim.)

7.—*Portable iron brooder with a heating lamp*

	No.	Length	Breadth	Depth	Quantity (decim.)
1 in. angle iron posts . . .	4	1 ft.	..	..	3·2 lbs.
1 in. angle iron for circles . .	2	6·5 ft.	..	..	10·4 lbs.
Expanded metal, ½ in. mesh .	1	4·5 ft.	¾ ft.	..	3·37 sq. ft.
Expanded metal, ½ in. mesh .	1	1 ft.	¾ ft.	..	0·75 sq. ft.
Deal wood planks . . .	2	6·5 ft.	..	1 in.	13 r. ft.

8.—*Permanent flock house for laying hens*

	No.	Length	Breadth	Depth	Quantity (decim.)
Excavation in soil long walls .	2	19 ft.	¾ ft.	1 ft.	28·5 c. ft.
Excavation in soil short walls .	2	15 ft.	¾ ft.	1 ft.	22·5 c. ft.
Filling with stone in mud long walls	2	19 ft.	¾ ft.	2 ft.	57 c. ft.
Filling with stone in mud short walls	2	15 ft.	¾ ft.	2 ft.	45 c. ft.
1 in. Shahabad paving with lime pointing	1	18·75 ft.	13·75 ft.	..	240 sq. ft.
Murum filling	1	18·75 ft.	13·75 ft.	·75 ft.	59·5 c. ft.
Brick masonry in lime long walls .	1	18·75 ft.	37 ft.	6 ft.	41·62 c. ft.
Brick masonry in lime front wall .	1	18·75 ft.	37 ft.	7 ft.	48·56 c. ft.
Deduct one door 3 ft. × 5 ft. . . . 15 sq. ft.					
Expanded metal 1 ft. × 13 ft. . . . 13 sq. ft.					
28 sq. ft.					
Brick masonry short walls . .	2	13·5 ft.	37 ft.	6·5 ft.	64·93 c. ft.
Concrete posts	1	7 ft.	1 ft.	1 ft.	7 c. ft.
Door	1	4·5 ft.	1·5 ft.	3·5 ft.	20·25 c. ft.
Expanded metal, ½ in. mesh .	1	13 ft.	1 ft.	..	13 sq. ft.
R. C. C. Block for water . .	1	18·75 ft.	1·5 ft.	¾ ft.	21·09 c. ft.

28 sq. ft.—Total deduction

	No.	Length	Breadth	Depth	Quantity (decim.)
8.—Permanent flock house for laying hens—contd.					
Perches	12		Lump		
G. I. Sheets roof	1	17·5 ft.	21·5 ft.	..	376·25 sq. ft.
Mangalore tiling with battons, etc.	1	17·5 ft.	21·5 ft.	..	376·25 sq. ft.
Mulmin cut teak posts . .	10	10 ft.	4 in.	4 in.	11·1 c. ft.
Mulmin cut teak purlins . .	5	17 5 ft.	4 in.	2 in.	4·8 c. ft.
Mulmin cut teak rafters . .	3	21·5 ft.	4 in.	4 in.	7·1 c. ft.
9.—Portable wooden fowl crate					
Teak wood posts	4	2 ft. 3 in.	2 in.	2 in.	0·25 c. ft.
Deal wood planks for partition and sides	12	2 ft.	6 in.	1 in.	24 r. ft.
Deal wood planks for bottom, top and back	12	2 ft. 10 in.	6 in.	1 in.	34 r. ft.
Deal wood planks for closing half front	12	1 ft.	3 in.	1 in.	12 r. ft.
Teak wood frame for front door .	1	8 ft.	½ in.	½ in.	0·125 c. ft.
Expanded metal, ½ in. mesh .	1	3 ft.	1 ft.	..	3 sq. ft.

SELECTED ARTICLE

A NOTE ON CLOVE CULTIVATION IN SOUTH INDIA*

BY

THE CURATOR,

Government Gardens, Ootacamund.

Botanical origin and distribution.—The clove is known botanically as *Eugenia caryophyllata* and belongs to the family *Myrtaceae* to which the myrtle, eucalyptus rose-apple and other well-known plants also belong. It is a small conical tree 30-40 feet tall and it is a very slow grower. It is said to continue prolific up to 75 years in favourable localities.

The clove is said to be indigenous to five small islands in the Moluccas, but it has spread through the agency of man to many parts of the tropical world and it grows particularly well in the islands of Zanzibar and Pemba which produce the greater part of world's supply. The clove is also grown in the Tinnevelley District and on the southern slopes of the Nilgiris of the Madras Presidency on a small scale, where it thrives up to 2,500 ft. above sea level.

Cultivation.—The clove prefers a somewhat sandy soil and a well distributed annual rainfall of not less than 60 in. The seeds should be collected for sowing as soon as mature, *i.e.*, when the seed covering becomes soft and purple in colour. They should be sown as soon as collected in nursery beds made up of any good garden soil to which a quantity of sand and leaf mould has been added. Select a site away from the roots of trees and dig the ground to a depth of one foot or more. The width of the beds should not exceed 4 feet, the length being determined by the number of seeds sown. The seed beds should be covered with a pandal to keep off the sun's rays, and the soil kept moist, but not waterlogged. Germination will take place in about six weeks, when more light should be given, otherwise the seedlings will become weak and leggy. The seedlings should be transplanted to planting baskets or established in balls of soil and moss when about 6 in. tall and grown on for planting out in their permanent quarters the following rainy season. A month or two before the planting season, say in April, pits 3 ft. square and 3 ft. deep and 20 ft. apart should be dug, and if the soil is poor, half filled with the soil removed from the pits and the other half made up with tank silt or any available good garden soil containing plenty of humus all well mixed together. As soon as the South West Monsoon begins, the young seedlings should be planted out in the centre of the pits in the baskets or balls of moss without disturbing the roots. On no account should the plants be allowed to become dry until they are about 3 feet tall after which weekly irrigations during the dry season should suffice.

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*Reprinted from the *Planters' Chronicle*, Vol. XXVIII, No. 1, January 14, 1933.

Clove trees may conveniently be grown between fruit trees in already established orchards wherever there is sufficient room, as they do not require much lateral space. For new orchards nutmegs, cloves, mangosteens and loose jacket oranges would make a good mixture, with papayas and plantains put out between as a catch crop. All these thrive under similar climatic conditions and the water requirements of the different species of tree can be regulated by irrigation. Mixed planting, however, requires a good deal of judgment and forethought and should not be undertaken without expert advice. If cloves are to be grown separately a green manure crop might with advantage be grown between the trees. This could be out to provide a mulch to the trees during the dry season and would also prevent soil erosion on steep land during heavy rains. I suggest *Tephrosia candida* or one of the *Crotalarias* as suitable plants for this purpose, or on very steep land *Leucana glauca* would be a useful plant, but the latter requires constant cutting to keep it within bounds.

The clove tree comes to bearing in from 10 to 15 years from planting and attains its full croping capacity in about 20 years when from 8 to 10 lbs. of dry cloves per tree may be expected. In the Tinnevelly District the yield is estimated to be between 1,500 to 2,000 lbs. of dry cloves per acre if the trees are planted from 150 to 200 feet apart, giving from 100 to 150 trees per acre ; but this figure is, in my opinion, very much over estimated as allowance must be made for a large percentage of the trees not producing crops annually. A nearer estimate based on yields obtained in other parts of the world is 800 to 1,000 lbs.

The clove of commerce is the unexpanded flower buds and these are gathered from the trees when they are dull blood red in colour. Gathering should be done in fine weather and the cloves spread thinly on mats in the sun to dry, which takes about a week if the weather is dry and longer during dull weather. At nights, or if rain occurs, the cloves should be removed to a light airy shed and spread out thinly until the weather becomes fine again. In some parts of the world cloves are dried over artificial heat and these are said to be a brighter brown and therefore more pleasing to the eye than the sun dried ones. The clove loses from 50 to 60 per cent. of its weight in drying.

The price obtained in South Indian bazaars is roughly Re. 1 per lb. for good quality cloves. The wholesale price in England varies from 8*d.* to 1*s.* per lb.

Cost of planting and maintenance.—The charges for the first ten years are estimated to be Rs. 1,500 per acre, but this must necessarily vary in different districts. Thereafter the probable cost of maintenance such as weeding, forking, mulching, etc., would be about Rs. 100 per annum.

Clove seeds and plants are available at the Agricultural Department Experiment Fruit Station at Burliar in the Nilgiri District, price of the former being Re. 1 per 100 and the latter annas four per plant or Rs. 15 per 100. Seeds can be supplied in September each year.

ABSTRACTS

Agricultural meteorology: Studies in micro-climatology, Part II. L. A. Ramdas, R. J. Kalamkar and K. M. Gadre. (*Ind. J. Agric. Sci.* 5, 1.)

The micro-climatological studies in Part I have been continued here. The paper discusses the variations of (*a*) the dry bulb temperature, (*b*) the wet bulb temperature, (*c*) the vapour pressure and (*d*) the percentage humidity at various heights above ground in the 'open' and inside a few crops at Poona during the winter of 1933-34 at the maximum and minimum temperature epochs.

"Maximum" dry bulb temperatures in tall crops like *jowar* and sugarcane were lower than in the open, the lowering being most pronounced near the ground; inside wheat they were higher than in the open. The "maximum" wet bulb temperatures were higher inside unirrigated crops and lower inside irrigated sugarcane. Water vapour in the air decreased with height and was also more inside crops than in the open.

"Minimum" temperatures inside crops were higher than in the open. The lowest temperatures occurred at some distance above the ground: a fact of some importance in frost phenomena. There was less water vapour near dry soil than at higher levels; this has been discussed elsewhere.

The values of temperature and humidity in the open were more closely correlated with the corresponding values inside crops at the "minimum" that at the "maximum" temperature epoch.

Further work is in progress. (*Authors' abstract*).

A biochemical study of the starches from old and new grain of different varieties of rice. D. L. Sahasrabuddhe and M. M. Kibe. (*Ind. J. Agric. Sci.* 5, 12.)

This was undertaken to ascertain whether there was any varietal difference in the appearance and reaction of rice starches and whether during storage rice starch undergoes any disintegration. The varieties used in the experiments were *Ambemohor*, *Kolamba*, *Patni*, *Halwar* and *Mahadi*. The study included (1) size of starch grains, action of boiling with water, action of alkali; (2) digestibility as indicated by hydrolysis with hydrochloric acid, diastase and pancreatin; (3) liquifaction of starch and (4) amylohydrolytic enzyme in stored and germinating rice.

The general conclusions are that the starch in fine rice used for boiling is more easily attacked by boiling with water or by the action of alkali, and more easily hydrolysed by hydrochloric acid or diastase than the starch from coarse varieties usually used for bread making. Similarly old rice is more easily attacked than new rice by the reagents mentioned. These results indicate that during storage the rice grains undergo a certain amount of disintegration making the starch more susceptible to attack by reagents and enzymes. The experiments further show that there is an amylohydrolytic enzyme present in stored rice grains which acts, although exceedingly slowly, on the starch of the rice grains. (*Authors' abstract*.)

The mechanical analysis of lateritic soils: 3. A new method using alkaline permanganate for oxidation of organic matter. JOGENDRA NATH CHAKRABORTY. (*Ind. J. Agric. Sci.* **5**, 41.)

Instead of hydrogen peroxide or sodium hypobromite, potassium permanganate in presence of sodium hydroxide was used for removal of organic matter in course of mechanical analysis of Indian lateritic soils. 20 grms. of soils were heated with 5 c. c. of normal sodium hydroxide and 50 c. c. of normal potassium permanganate. Fresh additions of normal potassium permanganate were made until the permanganate colour persisted for about half an hour. The mixture was cooled, acidified with hydrochloric acid and filtered by decantation. The precipitated manganese dioxide incorporated with the soil was removed by 25 per cent solution of sodium bisulphite in presence of about $N/2{\cdot}5$ hydrochloric acid . The soil was filtered and washed with 10 per cent sodium acetate solution just acidified with hydrochloric acid, until free from manganese and sulphate. The excess of sodium acetate was washed with a little water. The soil was shaken with 8 c. c. normal sodium hydroxide for 6 hours made up to 2 litres and subjected to pipette sampling. Results for clay, clay + silt and loss on solution obtained by this method were comparable to those by the International-Soda method. This method was shown to have dispersed completely lateritic soils in which large quantities of calcium carbonate and calcium sulphate were added. Alkaline permanganate method takes much shorter time for oxidation of organic matter than those requiring the use of either hydrogen peroxide or sodium hypobromite and is free from the disadvantages associated with the latter. (*Authors' abstract*).

Stinking smut (bunt) of wheat with special reference to *Tilletia indica* Mitra. M. MITRA. (*Ind. J. Agric. Sci.* **5**, 51)

Bunt on wheat in India is caused by three species of *Tilletia*, *T. caries*, *T. foetens* and *T. indica*. It is confined to the north-western parts of the country and does a good deal of damage. *T. caries* and *T. foetens* are restricted to the cooler regions while *T. indica* is confined to the plains. All the three species possess a stinking smell. *T. indica* can very easily be distinguished from other species by its partial attack on the grain and also by the black spore mass. In the other two species the whole of the grain excepting the seed-coat is destroyed and the spores are dusty olive brown or rust coloured in mass. Spores of *T. indica* are much larger than those of *T. caries* to which it is closely allied, and it appears that there are at least two physiologic forms of *T. indica*. The biometric analysis of data of spore measurements shows that this method can be employed to determine physiologic forms though it is not enough to identify the different species It has also been shown by a series of experiments carried out at Karnal and Pusa that infection with *T. indica* does not take place in Pusa whereas wheat at Karnal suffers from this disease almost every year. The failure of infection seems to be due to unfavourable climatic conditions at Pusa.

The measures of control that have been tried show that the percentage of infection can be reduced by treatment with fungicides like uspulun (universal), copper carbonate, ceresan and formalin but none of them can check the disease altogether. It seems that the fungicides cannot reach the spores which are well protected in mildly attacked grains

by the pericarp. It is supposed that hot water treatment may be a possible method to check the disease to a greater extent and as loose smut is also very common, on wheat one treatment may control both the diseases. Further, there is an indication that as in other bunts infection may take place from infected soil and so rotation of crops is advisable. It would be better if from time to time Karnal seed is renewed with seed from Pusa which is free from both bunt and smut. (*Authors' abstract*).

The relation of some plant characters to yield in sorghum. (G. N. RANGASWAMI AYYANGAR, M. A. SANKARA AYYAR, P. V. HARIHARAN, and D. S. RAJABHOOSHANAM. (*Ind. J. Agric. Sci.* **5,** 75.)

The correlation between grain yield per plant and eight other plant characters (excluding duration) have been determined in two irrigated and three rain-fed Coimbatore varieties of sorghum.

The diameter of peduncle, weight, length and thickness of ear-head, and straw weight have given high positive correlation values. These characters can be used as reliable indices in selecting for high yield.

The weight of 100 grains has given high correlation values in the irrigated varieties while in the three dry varieties it was low.

The length of peduncle is either not correlated or is negatively correlated with yield.

In the two irrigated varieties studied the duration was found to be negatively correlated with yield.

Partial and multiple correlations were also calculated. The total grain yield of a plant can be predicted very closely, when the diameter of peduncle, length and thickness of ear-head, and the weight of 100 grains are all known. (*Authors' abstract*).

NOTES

THE DEVELOPMENT OF COTTON CULTIVATION IN CENTRAL PROVINCES

The Publicity Officer, Indian Central Cotton Committee, writes :—

The progressive expansion of the area under Verum cotton in the Central Provinces and the practical achievements of research into a number of problems vitally affecting the cotton industry, financed by the Indian Central Cotton Committee, are some of the interesting facts recorded in the Annual Report of the Department of Agriculture, Central Provinces, for the year ending 31st March 1934.

Botanical research on cotton

Research on cotton with financial aid from the Indian Central Cotton Committee under the Botanical Scheme, renewed for another 5 years, was mostly concerned with the testing and multiplication of the two new strains—late Verum and V-434. The latter proved the most conspicuously successful under the most divergent conditions of soil and climate by virtue of its wilt-resistance, drought-resistance, prolific flowering capacity, quickness in forming buds and setting fruit, excellent lint characters and good ginning percentage. It has been specially selected for areas of short duration rainfall and seed sufficient to cover 2,000 acres has been obtained. In view of large demands for late Verum seed as a result of experiments, which have been in keeping with those of previous years, it was decided to multiply this strain as much as possible and seed for 16,000 acres is now available. New selections have been obtained by work on Bani E-B-31 and Bani 306, and high-yielding strains have been isolated from the white-linted types of Chanda 'jari'.

The purification of *G. indicum* and *G. cernaum* crosses which have shown great wilt-resistance is in hand and those which show uniformity of lint and good ginning percentage will be retained. Hybridization work consisted in the making of new crosses including E-B-31 × Bishnoor, Roseum Bishnoor, Verum × Roseum and Malvensis × Roseum.

Marketing of Verum cotton

The marketing of Verum cotton which was subsidized by the Indian Central Cotton Committee has been in operation and has definitely grown into a normal feature of the cotton policy in the Central Provinces. "This scheme", says Resolution of the Central Provinces Government, reviewing the Director of Agriculture's Report, "has certainly passed the experimental stage and its success and possibilities have been demonstrated beyond doubt."

The season which promised well in the beginning but proved disastrous, particularly to the Verum cotton crop in Nagpur, Wardha and Yeotmal districts, falsified expectations, for at least 7,000 bales were expected to be dealt with in the pools

and the bales actually sold were 5,087, 73 per cent of the output being provided by Buldana and Nimar districts. Verum cotton sold through these pools fetched a price equivalent to Rs. 226·04 per khandi f. o. r. Bombay basis. The average figure for Oomras was Rs.170·3 and the premium of nearly Rs. 56 per khandi over Oomras fetched by Verum is almost identical with that of last year. The scheme for marketing Verum cotton has thus put into the pockets of those who participated in it an additional income of Rs. 1½ lakhs.

Extension of Verum cotton

Very promising results have been obtained from the tests made on Government Farms and by private individuals by growing, on a field scale, new strains of Verum cotton which it is hoped, will eventually replace Verum 262. The cultivation of 'roseum' has had an added stimulus on account of the susceptibility of Verum 262 to unseasonal weather, but the prospects, on the balance, seem to be in favour of the new strains of Verum. This will have the effect of turning the main Oomras tract of India into a medium staple producing area. Verum has also continued to make headway in the Nimar district and 1,472 bales were sold through the marketing pool.

An investigation into the cost of growing cotton in the Central Provinces and its rotation crops has been started and is well under way through financial aid from the Indian Central Cotton Committee. The Committee has, during the year, spent an aggregate sum of Rs. 56,783-8-3 on its various schemes in the Central Provinces. In addition, two new schemes, entailing an annual expenditure of Rs. 30,862, have been placed on foot, *viz.*, an Entomological Scheme designed to find out the incidence of, and the damage done by, the Pink and Spotted Boll Worms in the Central Provinces and Berar and a scheme for the extension of Verum cotton in the Province. The all-round progress thus recorded is a gratifying reflection on the endeavours to improve cotton cultivation in the Central Provinces and owes a great deal to the "initiative, vigour and enthusiasm" for which the Resolution of the Central Provinces Government on the Report of the Agricultural Department, rightly praises the present Director and his predecessor.

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THE KATAMORPHISM OF IGNEOUS ROCKS UNDER HUMID TROPICAL CONDITIONS*

Sir John Burchmore Harrison, late Director of the Department of Science and Agriculture in British Guiana, died in 1926, leaving behind him the unrevised manuscript of what was perhaps his greatest work. Throughout the 37 years he spent in

* By the Late Professor Sir John Burchmore Harrison, Kt., C.M.G., M.A., F.I.C., F.C.S., F.G.S., F.G.S.A., etc. (Late Director of Science and Agriculture, Government Analyst and Geologist, British Guiana), with a Foreword by Sir E. J. Russel and a Preface by Professor F. Hardy. Published by the Imperial Bureau of Soil Science, Rothamsted. Experimental Station, Harpenden. Price 5*s*.

British Guiana he interested himself in the study of the processes of tropical weathering to which he directed his great powers of observation and analysis. He incorporated the results and conclusion of his life's work on the subject in a manuscript which was discovered by Mr. R. R. Follett Smith of the British Guiana Department of Agriculture in 1930, and forwarded to the Soil Bureau by Professor F. Hardy, of the Imperial College of Tropical Agriculture. The Bureau does not undertake the publication of original research work, but in this instance it has been privileged to do so on behalf of Demerara Proprietors, Ltd., and the British Association for the Advancement of Science, who have generously contributed the necessary funds. The laborious and difficult task of revising the manuscript after the death of its author has been carried out by Professor Hardy. The scientific world owes a debt of gratitude to the contributing bodies and to Professor Hardy for securing the publication of a work of unique value which could never have been printed without their assistance. It is doubtful whether such a detailed and far-reaching study of tropical soil-forming processes, in particular of lateritisation, has ever been made before, and (under present-day conditions) it is most unlikely that the opportunity and ability to repeat Harrison's work will again occur together. It may truthfully be said that it scarcely needs repetition, but it will serve as a sure foundation to further researches on a problem of increasing scientific and economic importance. The monograph should become a standard work of reference to all students of tropical geology and soils.

CONTENTS

Part I.—Introductory

Part II.—Katamorphism of basic igneous rocks under humid tropical conditions

Part III.—Katamorphism of itermediate igneous rocks under humid tropical conditions

Part IV.—Katamorphism of acidic igneous rocks under humid tropical conditions.

PERSONAL NOTES, APPOINTMENTS AND TRANSFERS, MEETINGS AND CONFERENCES, ETC.

The names of the following recipients of New Year Honours will be of interest to the Agricultural and Veterinary Departments in India :—

C.I.E. . . .	MR. MUHAMMAD SALEH AKBAR HYDARI, I.C.S., Deputy Secretary to the Government of India in the Department of Education, Health and Lands.
M.B.E. . . .	MR. HENRY HENNING LINCOLN of the Imperial Secretariat Service, Assistant Secretary to the Government of India in the Department of Education, Health and Lands.
Rai Bahadur . .	Rai Sahib MALIK CHARAN DAS, Secretary, Imperial Council of Agricultural Research.
Rao Bahadur . .	MR. GIYARPURAM NADATHUR RANGASWAMI AYYANGAR, B.A., I.A.S., Millets Specialist, Agricultural Research Institute, Coimbatore, Madras Presidency.
Khan Sahib . . .	MAULVI MUHAMMAD ABDULLAH, Provincial Veterinary Service, Punjab.
Rai Sahib . . .	MR. NIRMAL CHANDRA BASU, Assistant Fibre Expert, Bengal.
Rai Sahib . . .	BABU MANOHAR LAL, Personal Assistant to the Director of Agriculture, and Secretary, Board of Agriculture, United Provinces.
AHMUDAN-GAUNG-TAZEIK-YA-MIN.	U PE THAN, Deputy Director of Veterinary Services, Northern Circle, Mandalay, Burma.

Diwan Bahadur Sir T. VIJAYARAGHAVACHARYA, K.B.E., on return from leave, resumed charge of the office of the Vice-Chairman, Imperial Council of Agricultural Research on the forenoon of the 21st December 1934.

Under Rule 1(42) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Inter-University Board, India, have elected Professor C. N. VAKIL, M.A., M.Sc. (Econ.) (Lond.), F.S.S., University Professor of Economics, Bombay University, Bombay, as their representative on the Imperial Council of Agricultural Research, with effect from the 16th November 1934, in the vacancy caused by the relinquishment under the provision of Rule 5(3) of the said Rules and Regulations, of his seat on the Council by Dr. J. C. GHOSH, D.Sc., Head of the Department of Chemistry, Dacca University.

His Excellency the Governor-General in Council has been pleased, under the provisions contained in Rules I and 43 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the DIRECTOR OF AGRICULTURE AND FISHERIES, TRAVANCORE, as a member of the Imperial Council of Agricultural Research and also as a member of its Advisory Board.

His Excellency the Governor-General in Council has been pleased, under the provisions contained in Rules I and 22 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the DIWAN OF TRAVANCORE as a member of the Imperial Council of Agricultural Research and also as a member of its Governing Body.

The Governor-General in Council has been pleased to appoint Mr. A. K. YEGNA NARAYANA IYER, Director of Agriculture, Mysore State, to be a member of the Indian Central Cotton Committee, *vice* Dr. L. C. COLEMAN resigned.

In consequence of the vacancy caused by the resignation of Mr. F. G. TRAVERS, the Karachi Chamber of Commerce have nominated Mr. G. C. R. COLERIDGE to be a member of the Indian Central Cotton Committee, Bombay.

In consequence of the vacancy caused by the resignation of Khan Bahadur Maulvi MOHAMMAD OBAIDUR RAHMAN KHAN, the Government of the United Provinces has nominated Khan Bahadur Shah Nazar Hussain to be a member of the Indian Central Cotton Committee, to represent the cotton-growing industry in that Province.

The Governor-General in Council has been pleased on the recommendation of the Government of Bihar and Orissa, to nominate Mr. J. L. MERRIMAN, I.C.S., to be a member of the Indian Lac Cess Committee with effect from the 7th December 1934 to represent the interests of the lac cultivators in Bihar and Orissa, *vice* Mr. H. E. HORSFIELD, I.C.S., resigned.

Rai Sahib TEJ BAHN BAHL, B.A., Superintendent, Imperial Council of Agricultural Research Department, has been granted extension of extraordinary leave for six months, with effect from the 17th November 1934.

Mr. L. D. GALLOWAY, M.A., who landed in Bombay on the 13th December 1934, has been appointed Imperial Mycologist, Imperial Institute of Agricultural Research, in General Central Service, Class I, and assumed charge of his duties at Pusa on the 17th December 1934.

Mr. P. V. ISAAC, M.Sc., I.A.S., Second Entomologist (Dipterist), Imperial Institute of Agricultural Research, Pusa, has been granted leave on average pay for 8 months and in continuation, leave on half average pay for 2 months from the 2nd January 1935. with permission to prefix to the leave the Christmas and the New Year Holidays from 23rd December 1934 to 1st January 1935.

The services of Mr. W. TAYLOR, D.V.H., M.R.C.V.S., I.V.S., Officiating Director, Imperial Institute of Veterinary Research, Muktesar, have been placed at the disposal of the Government of the Punjab with effect from the 25th October 1934.

Mr. RIAZUL HASSAN, M.R.C.V.S., Assistant to the Professor of Pathology, Punjab Veterinary College, Lahore, has been appointed Deputy Director, Imperial Veterinary Serum Institute, Izatnagar, with effect from the 5th November 1934.

Madras

Mr. C. V. RAMASWAMI AYYAR, Assistant, First grade, Chemistry Section, has been appointed to the Madras Agricultural Service in the post of Assistant Agricultural Chemist sanctioned for Soil Survey in the Tungabhadra Project area.

Dr. S. KASINATHA AYYAR, Assistant, Second grade, Chemistry Section, has been appointed to the Madras Agricultural Service as Assistant Agricultural Chemist, with effect from the date of taking charge in the vacancy consequent on the appointment of Mr. P. Venkataramayya as Officiating Agricultural Chemist.

Mr. T. R. NARAYANA AYYAR, B.Sc. (Ag.), Upper Subordinate, fifth grade and Assistant in Millets, has been appointed to hold the temporary post of Physiological Botanist created for work in connexion with the Madras Physiological Scheme. The appointment will take effect from the date the officer concerned takes charge of his duties.

Mr. A. K. MITRA, M.R.C.V.S., Lecturer in Pharmacology, Madras Veterinary College, has been appointed to be acting Lecturer in Pathology and Bacteriology, Madras Veterinary College, with effect from 22nd October 1934 until further orders.

Mr. M. SUNDARANATHAN, Assistant Lecturer, Madras Veterinary College and probationer in the Madras Veterinary Subordinate Service, has been appointed to be acting Lecturer in Pharmacology, Madras Veterinary College, *vice* Mr. A. K. Mitra placed on other duty.

Mr. C. VENKATRATNAM CHETTI, on return from leave, has been appointed to be District Veterinary Officer, Bezwada.

Mr. N. MUNIAPPA PILLAI, Acting District Veterinary Officer, Bezwada, on relief has been appointed to be acting District Veterinary Officer, Vellore, reverting Mr. M. PONNAYYA to his permanent post in the Madras Veterinary Subordinate Service.

Bombay

Mr. W. J. JENKINS, M.A., B.Sc. (Edin.), Chief Agricultural Officer in Sind, has been granted leave on average pay for 4 months followed by leave on half average pay for 3 months and 13 days with effect from 14th March 1935 or the subsequent date of relief.

Mr. G. M. HOTCHAND, Head Clerk in the Office of the Chief Agricultural Officer in Sind, has been appointed to act as Assistant to the Chief Agricultural Officer in Sind, *vice* Khan Bahadur Gul Muhammad Abdur Rahman, with effect from the 10th September 1934.

Mr. C. S. PATEL, Cotton Superintendent, Surat, has been granted leave on average pay for 3 months with effect from the 17th December 1934 or the subsequent date of relief.

Mr. G. P. PATHAK, has been appointed to act as Cotton Superintendent, Surat, *vice* Mr. C. S. Patel proceeding on leave.

Mr. JAFFERALI ANSARI has been appointed to be Divisional Superintendent of Agriculture in Sind with effect from the 1st November 1934.

Mr. V. R. PHADKE, G.B.V.C., J. P., Principal, Bombay Veterinary College, has been granted leave on average pay for four months with effect from the 24th November 1934 or the subsequent date of relief.

Mr. M. MOHEY DEEN, M.R.C.V.S., Professor, Bombay Veterinary College, has been appointed to act as Principal, Bombay Veterinary College, *vice* Mr. V. R. Phadke proceeded on leave.

Mr. Y. N. MARATHE, Deputy Director of Veterinary Services, Bombay Presidency, has been granted leave on average pay for four months with effect from 3rd December 1934.

Mr. V. N. KULKARNI has been appointed to officiate as Deputy Director of Veterinary Services, Bombay Presidency, *vice* Mr. Y. N. Marathe proceeded on leave.

Bengal

Mr. A. R. MALIK, M.A., B.Sc. (Edin.), Deputy Director of Agriculture, Northern Circle, has been allowed leave for one month and ten days, *viz.*, leave on average pay for one month and leave on half average pay for the remaining period, in extension of the leave already granted to him.

Khan Sahib Saiyid SULTAN AHMAD, G.B.V.C., Vice-Principal, Bengal Veterinary College, has been allowed leave from the 12th November 1934 or any subsequent date on which he may proceed on leave up to 28th February 1935, *viz.*, leave on average pay for twenty-three days, and leave on half average pay for the remaining period.

United Provinces

Mr. SURJU SARAN ROY, L.AG., has been confirmed as Principal of the Gorakhpur Agricultural School, with effect from the 12th September 1934.

Mr. UDAI BHAN SINGH, M.SC., Imperial Institute of Agricultural Research, Pusa has been appointed as Mycologist at the Government Orchards, Chaubattia, with effect from the 10th July 1934.

Punjab

On return from leave Mr. H. R. STEWART, F.R.C.Sc.I., D.I.C., N.D.D., I.A.S., resumed charge of the office of Director of Agriculture, Punjab, Lahore, with effect from the 6th October 1934, relieving Khan Bahadur Maulvi Fateh-ud-Din, I.A.S., who reverted to his substantive appointment of Deputy Director of Agriculture, Jullundur.

Khan Bahadur M. FATEH-UD-DIN, B.A., I.A.S., Deputy Director of Agriculture, has been posted to Jullundur with effect from the 10th October 1934, relieving Mr. Charan Singh.

Mr. CHARAN SINGH, Extra Assistant Director of Agriculture, has been posted to Hansi, with effect from the 19th October 1934, relieving Mr. Tehl Ram, who reverted to his substantive appointment of Agricultural Assistant, 'A' Class, Multan.

Sardar Sahib Sardar KHARAK SINGH, M.A., I.A.S., Deputy Director of Agriculture, Montgomery, has been granted leave on average pay for three months and seventeen days and in continuation, leave on half average pay for one year, ten months and 12 days, with effect from the 25th September 1934 preparatory to retirement.

Khan Sahib AGHA YUSAF ALI KHAN, Extra Assistant Director of Agriculture, Multan, has been placed incharge of the duties of Deputy Director of Agriculture, Montgomery, with effect from the 25th September 1934 in a temporary post created for the purpose and relieving Sardar Sahib S. Kharak Singh, granted leave.

Mr. HARBANS SINGH, B.Sc. (Agri.) (Pb.), Agricultural Assistant, 'A' Class, Botanical Section, Punjab Agricultural College, Lyallpur, has been appointed Sugarcane Specialist (temporary), Lyallpur, with effect from the 10th November 1934 in a temporary post created for the Sugarcane Research Scheme and on probation for one year.

Mr. KHAN A. RAHMAN, B.Sc. (Edin.), Assistant Professor of Entomology, Punjab Agricultural College, Lyallpur, has been granted combined leave for two years outside India, Ceylon, Nepal or Aden with effect from the 20th September 1934.

Leave on average pay for nineteen days from the 20th September 1934 to 8th October 1934.

Study leave on half average pay for one year from 9th October 1934 to 8th October 1935.

Leave on average pay for seven months and eleven days, from 9th October 1935 to 19th May 1936.

Leave on half average pay for four months from 20th May 1936 to 19th September 1936.

Mr. KRISHAN GOPAL BHANDARI, Officiating Agricultural Assistant, 'A' Class, Entomological Section, Punjab Agricultural College, Lyallpur, has been appointed Officiating Assistant Professor of Entomology, Punjab Agricultural College, Lyallpur, on probation for six months with effect from the 1st October 1934, *vice* Mr. Khan A. Rahman granted leave.

On return from leave Mr. LAL SINGH, B.Sc. (Hons.), M.Sc. (Calif.), resumed charge of the post of Fruit Specialist, Lyallpur, on the 10th October 1934, relieving Mr. Bal Singh who assumed charge of the temporary post of Assistant Fruit Specialist Lyallpur.

Mr. ISHWAR DAS MOHENDRA (Extra Assistant Conservator of Forests), on special duty under Financial Commissioner, Development, as Marketing Officer, has been appointed Marketing Officer, Lahore, with effect from the 29th June 1934 in a temporary post created for six months under the Director of Agriculture, Punjab.

Mr. RIAZ-UL-HASSAN, G.P.V.C., M.R.C.V.S, P.V.S., Assistant to the Professor of Pathology, Punjab Veterinary College, Lahore, has been appointed to perform the duties of the post of Professor of Medicine, Punjab Veterinary College, Lahore, with effect from the 17th September 1934, *vice* Mr. T. J. EGAN, I.V.S., Offg. Professor of Medicine, Punjab Veterinary College, appointed as Director, Civil Veterinary Department, United Provinces.

Mr. ABDUL QAYUM KHAN, L.V.P., Veterinary Assistant Surgeon, incharge Veterinary Hospital, Sheikhupura, has been appointed Offg. Assistant to the Professor of Pathology, Punjab Veterinary College, Lahore, with effect from the 23rd October 1934 *vice* Mr. Riaz-ul-Hassan appointed to carry on the duties of the post of Professor of Medicine, Punjab Veterinary College, Lahore.

On reversion from the Imperial Institute of Veterinary Research, Muktesar (U. P.), where he had been deputed to officiate as Director, Mr. W. TAYLOR, M.R.C.V.S., D.V.H., I.V.S., resumed charge of his appointment as Principal, Punjab Veterinary College, Lahore, on the 1st November 1934, relieving Capt. U. W. F. WALKER, M.C., M.R.C.V.S., I.V.S., who reverted to his substantive appointment as Professor of Surgery, Punjab Veterinary College, with effect from the same date.

On relief by Mr. W. Taylor, from the 1st November 1934, Mr. RIAZ-UL-HASSAN, M.R.C.V.S., P.V.S., Officer incharge of the duties of the post of Professor of Medicine, Punjab Veterinary College, proceeded to Izatnagar to join his new appointment as Deputy Director, Imperial Veterinary Serum Institute.

On return from leave granted to him Mr. W. S. READ, Assistant Superintendent (Fodder), Government Cattle Farm, has been reposted to Hissar with effect from the 7th November 1934, relieving Mr. Mohammad Jan, P.V.S. The unexpired portion of his leave has been cancelled.

Mr. MOHAMMAD JAN, P.V.S., Offg. Assistant Superintendent (Fodder), Government Cattle Farm, Hissar, has been appointed Deputy Superintendent (Stock), Government Cattle Farm, Hissar, with effect from the 7th November 1934, relieving Mr. Ram Lal Kaur, M.R.C.V.S., who reverts to his non-gazetted appointment of Veterinary Assistant Surgeon, Government Cattle Farm, Hissar.

Mr. TORA BAZ KHAN, P.V.S., Deputy Superintendent, Civil Veterinary Department, Ambala, has been transferred to Lahore with effect from the 13th November 1934, relieving Khan Sahib Kh. Ghulam Hassan, P.V.S., Offg. Superintendent, Civil Veterinary Department, Lahore and Jullundur divisions, Ferozepore, of additionl charge.

MR. MOHAMMAD SHARIF KHAN, B.A., Demonstrator, Anatomy Section, Punjab Veterinary College, Lahore, has been appointed Officiating Deputy Superintendent, Civil Veterinary Department, Ambala, with effect from the 5th November 1934, relieving Mr. Tora Baz Khan, P.V.S., transferred.

Burma

On return from leave, Mr. H. F. ROBERTSON, B.Sc., I.A.S., has been reposted as Deputy Director of Agriculture, Myingyan Circle, in place of U Saw Tun, B.A.S., Class II, who will remain as Assistant Director of Agriculture, Myingyan Circle.

U. SAW HLA U, G.B.V.C., Veterinary Superintendent, has been granted extension of leave on average pay (on medical certificate) for two months in continuation of the leave granted to him.

Bihar and Orissa

Lt.-Col. C. A. MacLean, M.B.E., M.C., M.A., B.Sc., I.A.S., Deputy Director of Agriculture, has been promoted to the selection grade in the Indian Agricultural Service, with effect from the 1st August 1934, *vice* Mr. D. R. Sethi, confirmed as Director of Agriculture, Bihar and Orissa.

The term of appointment of Mr. Muhammad Ismail Malik, B.Sc., M.R.C.V.S., Special Officer in the Civil Veterinary Department, which was extended up to the 30th November 1934, has further been extended for one year, with effect from the 1st December 1934.

Assam

Mr. J. N. Chakravarty, B.A., Offg. Director of Agriculture, Assam, has been promoted to the selection grade in the Indian Agricultural Service, and appointed as Director of Agriculture, Assam, in Class I of the Assam Agricultural Service, with effect from the 16th May 1934.

NEW BOOKS

On Agriculture and Allied Subjects

Reshaping Agriculture: By O. W. Willcox. Pp. 157 (New York: W. W. Norton and Co., Inc.; London: George, Allen and Unwin, Ltd., 1934.) 7*s.* 6*d.* net.

Entomology with special reference to its Ecological Aspects. By J. W. Folsom. Revised by R. A. Wardle. Fourth Revised Edition. Pp. 619. (London: John Murray, 1934.) 21*s.* net.

The Use of Fertilizers: a Guide to the Manuring of Crops in Great Britain. By A. S. Barker. Pp. x+204. (London: Oxford University Press, 1935.) 7*s.* 6*d.* net.

Dictionary of Terms relating to Agriculture, Horticulture, Forestry, Cattle-breeding, Dairy Industry and Apiculture; in English, French, German and Dutch. By T. J. Bezemer. Pp. VIII+251+294+267+249. (London: George, Allen and Unwin, Ltd., 1934.) 25*s.* net.

The Diseases and Curing of Cacao. H. R. Briton Jones. Pp. x+161. (London: Macmillan and Co., Ltd., 1934.) 10*s.* net.

Essays upon Field Husbandry in New England and other Papers, 1748-62. By J. Eliot. Edited by H. J. Carman and R. G. Tugwell. (New York: Columbia University Press; London: Oxford University Press, 1934.) 17*s.* 6*d.* net.

Statistical Methods for Research Workers. By R. A. Fisher. (Biological Monographs and Manuals.) Fifth Edition, revised and enlarged. Pp. XIV+319. (Edinburgh and London: Oliver and Boyd, 1934.) 15*s.* net.

The Genetics of Garden Plants. By M. B. Crane and W. J. C. Lawrence. Pp. XVI+236. (London: Macmillan and Co., Ltd., 1934.) 10*s.* 6*d.* net.

Encyclopædia of Veterinary Medicine, Surgery and Obstetrics. Edited by G. H. Wooldridge, Second Edition. Pp. XCVIII+1776; Illust. 362; 6 col. plates. (London: Oxford University Press, 1934.) Price £6 6*s.* net.

Practical Bacteriology: an Introductory Course for Students of Agriculture. By Andrew Cunningham, D. Sc. Second Edition. Revised and enlarged. Pp. VIII+203, and 26 figs. (Edinburgh and London: Oliver and Boyd, 1934.) Price 7*s.* 6*d.*

Small Fruit Culture. By J. S. Shoemaker. Pp. xv+434+52 figs. (Philadelphia: P. Blakiston's Son & Co., Inc., 1012, Walnut Street. 1934.) Price $3·50.

Die Schafzucht in den uberseeischen Woll and Schaffleisch Ausfuhrlandern. By Stefan Taussig; and Die Karakut Zucht in ihren Heimatlande Turkestan. By Prof. Dr. A. Golf. (Berlin: Paul Parey, 1934.) R. M. 6,50.

GIPD—M554(A) IC of AR—16-4-35—1,000.

ORIGINAL ARTICLES

A SUMMARY OF THE PERFORMANCES OF SOME IMPORTANT COIMBATORE SUGARCANE SEEDLINGS IN BIHAR AND ORISSA

ERRATA.

Agriculture and Live-stock in India, Vol. V, Part III.

Contents—line 4, put a comma after the word "**Research**".

Page 251, line 6—*For* "WHEATI PRCES" *read* "WHEAT PRICES".

Page 284, under Lyallpur, against August 27th, below *Maghar*, *for* "2 3 $3\frac{1}{4}$" *read* "2 3 $3\frac{3}{4}$."

Page 288, heading of column 5, *for* "*Chhauni*" *read* "*Chhanni*".

Page 315, heading, *for* "REVI WS" *read* "REVIEWS".

Page 324, under FRUITS, after item 89 *insert* items 90 and 91.

... The data now offered will prove of considerable benefit to us in our future sugarcane research work. It is hoped that these summaries will be of use to the supplying station in its future breeding programmes and to other sugarcane research stations in Northern India in their work of evaluating cane types in relation to environment.

Co. 205 (VELLAI ♀ × S. *spontaneum* ♂)

Germination slow but sure; cane-bud possessing very high viability; stand average to good, depending upon soils of light or heavy texture; habit erect, canes generally upright, slightly curved and crawling under marsh or water-logged conditions; owing to conservative growth stands admirably through hot weather, maintaining narrow, dark—green, medium-abundant foliage; tillers strongly in heavy soils; responds quickly to rains and grows very fast in steamy weather; keeps erect during and after rains; borer trouble slight, yellowing occasional in usar patches and ill-drained plots, mosaic in young age pronounced.

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ORIGINAL ARTICLES

A SUMMARY OF THE PERFORMANCES OF SOME IMPORTANT COIMBATORE SUGARCANE SEEDLINGS IN BIHAR AND ORISSA

BY

D. R. SETHI, I.A.S.,

AND

K. L. KHANNA, B.Sc. (Agri.),

Sugarcane Specialist, Bihar and Orissa

For a number of years the departmental farms in Bihar and Orissa have been testing Coimbatore sugarcane seedlings supplied year after year by the Imperial Sugarcane Expert. Stock has now been taken of their performance under varied soil and climatic conditions prevailing in the province The collection of data has been done mainly by Mr. K. L. Khanna, Sugarcane Specialist, Bihar and Orissa. The thanks of the Department are due to the Imperial Council of Agricultural Research whose generous grant made possible the appointment of the Bihar and Orissa Sugarcane Specialist without whose assistance it would have been difficult to review the past work. The data now offered will prove of considerable benefit to us in our future sugarcane research work. It is hoped that these summaries will be of use to the supplying station in its future breeding programmes and to other sugarcane research stations in Northern India in their work of evaluating cane types in relation to environment.

Co. 205 (Vellai ♀ × S. *spontaneum* ♂)

Germination slow but sure; cane-bud possessing very high viability; stand average to good, depending upon soils of light or heavy texture; habit erect, canes generally upright, slightly curved and crawling under marsh or water-logged conditions; owing to conservative growth stands admirably through hot weather, maintaining narrow, dark—green, medium-abundant foliage; tillers strongly in heavy soils; responds quickly to rains and grows very fast in steamy weather; keeps erect during and after rains; borer trouble slight, yellowing occasional in usar patches and ill-drained plots, mosaic in young age pronounced.

Thin cane with generally upright habit; hard rind, fibre 17·8 per cent., pith pronounced in dry years, cavity late in the season; joints 5·16 in., girth 2·26 in., splitting badly and in almost every joint; shooting rare; rooting under water-logged conditions quite pronounced; stands remarkably through cold weather resisting frost, ripening about March, maintaining maximum purity level during March, rapidly deteriorating against hot winds.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November .	64·27	14·73	10·69	72·6	8·51
January . .	65·64	15·20	12·16	80·0	9·81
March . .	67·20	17·16	14·83	86·4	11·62
April . .	64·10	19·20	16·00	83·3	12·80

Root-system strong, adaptive and deep penetrating, capable of utilizing both upper and lower surfaces equally well, thickly branched at ends.

A special condition cane; thin; high-fibred, strong grower; agriculturally good chemically mediocre; not acceptable to mills owing to difficulties of milling and low rendement; has proved particularly valuable for the flooded and the saline tracts.

Co. 210 (P. O. J. 213 GENERAL COLLECTION)

Germination fair and quick, bud losing viability after a short time in a high soil-moisture environment; stand good in comparatively light types of soil; habit generally erect, canes occasionally bending towards top; stands through hot weather quite well, maintaining medium-broad, light-green, medium-abundant foliage; tillers strongly, responds to rains or any other favourable circumstance quickly, has been observed in certain years to grow very fast adding as much as 27 inches in a fortnight to its growing stalk; usually upright, occasionally falling about in patches during rains; shoot borer bad, top-rot pronounced in wet years, yellowing slight to occasional under heavy land conditions; tolerates certain amount of *usar*, susceptible to red-rot and to mosaic in earlier stages.

Medium cane with straight habit, medium-hard rind, fibre 15·2 per cent., pith and cavity pronounced at maturity; joint 6·28 in., girth 2·95 in.; splitting rare, shooting near top in diseased stalks very pronounced; rooting not conspicuous; does very well through cold weather, maintains green top and does not flower;

ripens about February when it gives maximum sugar, deteriorates considerably in April.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November . .	65·30	11·70	8·84	75·5	7·60
January .	63·48	14·37	11·75	81·8	9·68
March . .	67·10	17·54	15·25	87·0	12·93
April . .	60·60	17·50	14·68	83·9	12·36
May . .	56·40	18·12	14·13	78·0	11·40

Root-system strong and penetrating but suffering under badly-aerated 'environ'.

A medium cane for light lands, does quite well in years of short rainfall and is an excellent ratooner; has not suited heavy lands and laterite soils in the province; chemically a mediocre.

Co. 213 (P. O. J. 213 ♀ × Kansar ♂)

Germination fair and quick, bud keeping viable for a considerable time under North Bihar conditions; stands fair to good in light to heavy soils; owing to spreading habit of almost covering the ground in earlier stages, manages to get through dry weather remarkably, maintaining medium-broad, green and abundant foliage; tillers strongly, maximum number of tillers being thrown out in a drier summer rather than in a milder one; responds to rains and other favourable circumstances fast enough to reap the fullest benefit but suffers if rainfall is not right up to the average and well distributed, keeps beautifully erect during and after rains; of late years trouble from shoot and root borer has become very acute; yellowing frequent in areas with poor drainage and high alkalinity, very susceptible to *usar*, mosaic in some cases, top rot rare, preferred by white-ants.

Medium cane with upright habit, medium-hard rind, fibre 13·4 per cent., pith and cavity only in dry years or very late in the season, joint 4·45 in., girth 3·45 in.-splitting absent; shooting and rooting rare; ripens about mid-January and maintains admirably till mid-April, deterioration in cut canes very slow; gives higher per cent sugar in certain sections of South Bihar and Orissa.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November. .	64·47	13·13	10·0	75·2	8·28
January . .	66·01	15·00	12·12	80·8	9·96
March . .	68·82	17·68	15·42	87·2	13·45
April . .	62·60	18·83	15·85	84·2	13·34
May . .	59·06	18·60	14·78	79·5	11·47

Root-system strong and thick, very adaptive to extensive range of soils and climate, firmly held and very vigorous at surface in a well-distributed rainfall.

A medium cane for good lands, with high tonnage in a favourable year; clean habit, pure juice and high mill recovery make it the universal cane in the province.

Co. 214 (Str. Mauritius ♀× M. 4600♂)

Germination frequently poor and gappy and seed question always troublesome; bud viability high, stand average; habit semi-erect to reclining, cane crawling and bending in all directions; stands through hot weather very well, maintaining narrow, green, sparse foliage, is at no great disadvantage in a scanty rainfall year, tillers strongly, responds quickly to rains and grows vigorously in July adding as much as 18·0 in. in a fortnight; a dirty mass of canes after rains causing lot of harvesting difficulties; borer pronounced in wet years, resistant to mosaic; susceptible to *usar* and water-logging.

Thin cane, with bad habit, soft rind, fibre 16·0 per cent, pith and cavity pronounced, joint 4·26 in., girth 1·96 in. splitting rare; rooting and shooting frequent, early ripening, undergoes rapid deterioration after January.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	67·90	17·5	14·9	85·1	11·60
December .	63·00	18·4	15·8	86·0	13·17
January . .	62·40	19·06	15·3	80·3	12·85
February . .	58·70	18·7	14·3	78·7	10·36

Root-system strong and deep penetrating, adaptive within a very limited range.

An early mill cane with high sucrose and low tonnage; very hardy; essentially a mill cane, and as such not in favour with free growers.

Co. 281 (P. O. J. 213 ♀× Co. 206 ♂)

Germination fair to good, depending upon soil moisture conditions; bud viability high; stand average, habit semi-erect and oblique when young, erect later, grows successfully through hot weather, maintaining medium-broad, dark-green, medium abundant foliage and showing characteristic tip drying and inrolling of leaves; individual clumps growing ideally and indicating great possibilities of the cane; essentially an irrigated type; tillers satisfactorily in well-drained open soils; responds quickly to rains; highly susceptible to bad drainage and *usar*; reported

to have done well in paddy-fields in Madras Presidency, but has not given encouraging results under South Bihar conditions; might suit Orissa where it is under trial; borer occasional; mosaic rare.

Medium thick cane with excellent habit, soft rind, fibre 12·9 per cent; slightly pithy under unirrigated conditions or with deficiency of soil moisture, cavity absent joint 5·4 in. girth 3·15 in., splitting moderate; shooting rare except late in the season; very early in ripening carrying high sucrose with high purity; ripens about beginning of December and goes on improving till February, falling off in March, flowers occasionally and rarely sets, tops begin drying about March, keeps admirably on cutting till mid-February after which deteriorates rather rapidly.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November .	64·6	11·12	13·39	78·2	11·40
December .	64·0	18·45	15·21	82·6	12·76
January . .	61·0	18·94	16·67	88·4	13·94
February . .	58·0	21·01	19·41	92·3	15·90
March . .	56·7	21·62	18·42	85·2	14·56

Root-system strong, penetrating, tapping both top and bottom layers through thickish laterals, firmly held, possessing high tensile powers.

An ideal cane both agriculturally and chemically, does not seem to have suited Bihar. Performance of individual clumps in field gives one impression that the seedling has big capabilities provided it can be grown. Irrigation and other factors which will lead to good performance are under investigation.

Co. 285

Germination fair, bud viability high, stand average to good under different soil conditions; habit erect; canes usually straight, rarely falling about under water-logged conditions; keeps up splendidly during dry months, maintaining narrow, dark-green, abundant foliage; tillers shyly, at times only mother shoot growing; improves in heavy lands; likes steamy weather and keeps up erect during and after rains; borer slight, yellowing and mosaic occasional, slightly susceptible to high ranges of alkalinity, appears quite at home at 8·0 pH, stands water-logging and submergence very well.

Thin to medium cane with upright habit; hard rind, fibre 15·9 per cent, pith and cavity pronounced under dry conditions; pith prominent in immature joint under water-logged conditions; joint 5·62 in., girth 2·38 in.; splitting rare; shoot

ing under wet 'environ'; maintains well through winter, keeps green top; matures very early under South Bihar conditions, in North Bihar and Orissa a mid-season cane, better than Co. 205 in tonnage and juice quality, deteriorates on keeping.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	63·6	15·92	12.23	76.3	10.16
January . .	64·7	16·40	13.40	81.72	11.19
March . .	63·5	18·52	16.37	89.41	13.32
April . .	62·0	18·62	15.27	82.01	12.54

Root-system strong and adaptive, profuse development of aerial roots make it eminently flood-resistant.

Co. 205 class of cane for special conditions, better in sugar value and tonnage, but is not acceptable to mills owing to high fibre and low mill recoveries; suited to Shahabad (South Bihar) where it makes vigorous and heavy growth and ripens about December.

Co. 290 (Co. 221♀ × D. 74♂)

Germination good and fast, bud viability low; stand poor to good in different classes of soil, seemingly best under rich conditions; habit rather oblique when young, later erect; suffers during summer when leaves show withering prominently; performs better under Chota Nagpur and irrigated conditions when it maintains broad, green, medium-abundant foliage; tillers strongly; responds to rains quickly, often falling; prefers heavy soil and intensive cultivation; highly susceptible to *usar* and water-logging; yellowing pronounced; borers in dry year very bad; top-rot occasional; mosaic rare, damage by animals like rats, pigs and jackels heavy.

Thickish cane, at times slightly curved and liable to tumbling, soft rind, fibre 12·8 per cent, pith and cavity developing in a dry year during rains, joint 4·1 in., girth 3·55 in., splitting rare or occasional, shooting very pronounced; rooting rare; an early ripening cane with low keeping qualities, ripens about December and maintains till February, much earlier under South Bihar conditions where it shows very high purity, flowers rarely, tops begin drying about March.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	61·6	15·4	12·94	84·0	11·3
December . .	63·0	17·2	15·82	92·0	13·6
January . .	63·7	18·4	17·37	94·4	14·9
February . .	58·9	19·4	16·81	86·7	12·8

Root-system strong, thick but superficial, under intensive farming heavy mass at surface, thinly branched, not highly adaptive.

Thickish cane, early ripening and carrying very high quality juice, preferring rich conditions for growth; not an unirrigated type; has given very high yields at Kanke (Ranchi) in Chota Nagpur, has not given encouraging performance agriculturally under South Bihar conditions, though has shown very early maturity and high quality juice.

Co. 299 (Co. 213 ♀ × P. O. J. 1410 ♂)

Germination slow and gappy, filling up later; habit generally upright, canes slightly curved towards top; stand better in a comparatively heavier soil; ow ng to slow and bushy growth stands well through hot weather, maintaining narrow, dark-green, medium-abundant foliage; tillering not strong; responds quickly to rains making rapid growth, prone to lodging during rains in light soils, often keeps almost upright after rains; borer slight, yellowing occasional, susceptible to *usar* conditions and bad drainage.

Thin to medium cane slightly thickening upwards and feebly zig-zag; rind medium-hard, fibre 14·4 per cent., pith at times during rains, cavity absent or rare; joint 5·0 in., girth 3·0 in., ocasionally splitting, shooting marked in crop kept standing in field late in the season, rooting on basal joints conspicuous under water-logged conditions otherwise rare; early ripening, giving purity of 85·0 in early December, maintains till February when it drops off badly; deterioration on keeping very little in winter months.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November. .	63·0	18·20	15·28	83·5	12·92
December .	60·2	20·29	17·32	85·8	14·58
January . .	60·0	20·56	17·04	84·0	13·96
February . .	54·3	20·72	16·39	79·1	10·65

Root-system superficial but strong, flushing profusely during rains when it makes extensive lateral development, firmly held due to suitable angular development.

An early cane with better tonnage than Co. 214 and having as good sucrose content, ready for milling in November; has been distributed as an early mill cane in North Bihar; shows earlier ripening and decidedly superior juice quality under South Bihar conditions particularly at Sabour, Jamui, and Banka where

purity as high as 93·92 with 21·48 sugar has been obtained. This excellent chemical performance of the cane was noticed as early as 1930 at Sabour but owing to low cane acre-yields and absence of any sugar mill it has not so far been distributed in that area.

Co. 300 (Co. 213♀ × P. O. J. 1410♂).

Germination fair and quick, bud viability low, stand better in heavier types of soil, habit erect, slight spreading early in the season; medium-broad, dark-green, abundant foliage, droops and suffers from protracted drought; tillers sparsely in light soils, improving with manuring and irrigation; responds to rains quickly; stands upright during and after rains, susceptible to high alkalinity but stands lowland conditions; suffers badly from top-rot in steamy weather, yellowing noticed in *usar* patches, mosaic rare, leaf hoppers occasional.

Medium cane, straight-sided, medium-hard rind, fibre 13·8 per cent.; pith and cavity both present at maturity; joint 4·0 in.. girth 3·5 in.; splitting absent; shooting occasional in top joints; rooting in basal joints in humid atmosphere; occasionally flowers; matures early January commanding position between early mill varieties and mid-season ones; under South Bihar conditions ripens earlier giving superior juices, comparing favourably with Co. 299 in December; improves till March after which slowly falls off; little deterioration on keeping in winter months.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	67·39	12·90	8·94	70·59	7·47
December .	68·75	14·80	14·97	80·86	9·89
January . .	65·60	17·18	11·46	94·20	11·90
February . .	63·50	19·14	17·03	88·9	13·94

Root-system strong, superficial but thick and firmly held; adaptive to certain extent on uplands.

Has not shown performance good enough to merit distribution in North Bihar though looks quite promising both agriculturally and chemically in South-East Bihar.

Co. 301 (Co. 213♀ × P. O. J. 1399♂)

Germination good particularly if cane is planted a little earlier in the season when temperature is still low; bud viability low; in late planting buds have been observed to shrivel and dry up giving gappy germination; stand average to good

in soils of light to heavy texture ; habit semi-erect to erect at maturity, occasionally falls about in rains; stands drought well, maintaining medium-broad, healthy-green, medium-abundant foliage ; tillers sparsely in light soil, responds statisfactorily to rains, growing fast in steamy weather; top-rot in wet weather pronounced, borer considerable early in the season ; yellowing only in restricted patches, mosaic rare ; stands submergence and is eminently flood-resistant.

Medium-thick cane, medium-hard rind, fibre 13·9 per cent., pith and cavity slight appearing late in the season ; more often solid texture ; joint 5·3 in., girth 3·5 in.; splitting occasional and confined to basal joints ; shooting and rooting rare ; does not flower and maintains condition till March, ripening about mid-December improving in January, under Sepaya conditions maturity is reached only in March ; almost similar to Co. 300 in progress of ripening.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	67·8	13·99	10·52	75.1	8.62
December .	67·7	15·92	13·80	86.7	11.31
January . .	70·4	17·74	15·61	88.0	12.79
March . .	64·6	19·02	15·90	83.6	12.48

Root-system adaptive and penetrating.

Medium cane ; agriculturally satisfactory ; comes in between the early mill varieties and the mid-season ones.

Co. 303 (Co. 221 ♀× P. O. J. 1507 ♂)

Germination good, rarely patchy, bud viability high keeping as late as rains under North Bihar conditions ; habit spreading almost shading soil in rows ; very thick stand particularly during hot months ; maintains narrow, green, medium-abundant foliage ; tillering medium strong, open ; best performance in heavier types of soils, bucks up fast in rains putting forth rank growth ; lodging pronounced during rains in light soils, whole clumps falling owing to weak root hold ; borers pronounced yellowing rare ; tolerates certain amount of *usar* but is highly susceptible to bad drainage.

Thin to medium cane, rind medium-hard, fibre 13·6 per cent., pith at maturity, cavity rare, joint 4·6 in., girth 3·0 in., splitting common, buds swollen and protruded, shooting quite pronounced very late in the season ; rooting in lodged stalks,

does not flower and maintains till March after which falls off rapidly, ripening phase similar to Co. 213 except that it suffers pronounced deterioration on keeping.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	65·7	14·02	10·87	77·6	8·85
January . .	66·9	16·96	14·13	83·4	11·73
March . .	68·2	19·6	18·03	88·8	14·06
April . .	60·1	19·00	14·96	78·2	12·42

Root-system adaptive to variety of soils, penetrating in dry weather, more frequently shallow and superficial, spreading and thinly branched, poorly held, clumps falling as a whole; can be ratooned advantageously owing to heavy root mass near surface.

Cane similar to Co. 213 in growth as well as ripening phases; agriculturally bad owing to lodging tendencies; chemically superior to Co. 213 carrying over 1·0 per cent. in sugar value; bad habit could be satisfactorily dealt with by an intelligent ryot through mixed planting.

Co. 312 (Co. 213 ♀×Co. 244♂)

Germination good, rarely gappy if planted early in the season, bud viability quite high; habit semi-erect to spreading in early stages, often upright later, lodges badly in rains on light soils; stands through hot weather admirably, maintaining medium-broad dark-green, abundant foliage, tillers strongly and responds quickly to showers when throws out large number of shoots; borer slight, yellowing occasional in *usar* patches; tolerates water-logging to a certain extent, leaf hoppers bad towards September.

Medium cane, with predisposition to lodging; medium-hard rind, fibre 14·7 per cent., cavity at maturity, slight pith during hot weather and rains; joint 5·19 in., girth 3·14 in.; splitting absent; shooting and rooting pronounced in lodged stalks; maintains through cold weather; ripening about end of February and early March; rapid deterioration on keeping; under South Bihar conditions ripens in December improving in quality till March.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November. .	65·43	11·39	8·67	76·1	7·31
January . .	67·97	13·65	10·58	79·9	9·06
February . .	65·06	17·01	15·37	90·4	13·70
March . .	66·30	17·11	14·87	86·9	13·13
April . .	58·12	17·81	14·43	81·0	11·47

Root-system strong and adaptive, deeply penetrating in dry weather, superficial during rains, with fair root hold and extensive development in Sabour soil.

Medium cane with bad habit but very high tonnage, strong grower, chemically mediocre; under South Bihar conditions particularly at Sabour appears very promising both agriculturally and chemically, rarely lodges and gives early in the season high quality juice.

Co. 313 (Co. 213 ♀× Co. 244♂)

Germination fast and thick, bud viability low; stand best in loamy soil; gets through hot weather very successfully, maintaining medium-broad, green, medium-abundant foliage; habit semi-erect and open when young, almost erect at maturity, rarely falling during high winds in light soil, quite upright in soils of heavy texture tillering strong under North Bihar condition, rather restricted at Patna (South Bihar); responds quickly to rains adding as much as 22·6 in. in a fortnight, loves steamy weather coupled with sunshine; mosaic and borer pronounced during early stages only, top-rot in wet weather occasional, tolerates *usar* and water-logging to a certain extent, recently shown flood-resistance.

Medium cane, soft rind, fibre 13·9 per cent.; pith and cavity pronounced as maturity, former appearing as early as June; joint 5·73 in., girth 3·34 in.; splitting occasional in basal joints; shooting rare unless kept long after passing of peak maturity; rooting usually absent; Christmas cane maturing end of December though worth milling first week of December under Tirhut conditions; maintains till end of March after which falls off; shows little deterioration on keeping in winter months, flowers profusely and sets viable seeds in the open in certain parts of the province; in South Bihar matures as early as November and keeps till March giving superior juices; under low land conditions at the Sugarcane Research Station has shown over 94·0 purity in December.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November . .	61·6	17·06	13·22	77·4	10·19
December .	64·8	19·14	16·23	84·9	13·72
January . .	62·3	20·64	18·35	88·9	14·24
February . .	64·4	21·63	19·22	88·5	15·01
March . .	62·2	22·30	19·99	89·3	14·60

Root-system deep, penetrating and adaptive; capable of utilizing favourable circumstances to advantage; roots strongly held, thickly branched and with extensive lateral development.

Rather thickish green cane, very good grower agriculturally in a favourable year ; Christmas cane which might find favour with mills as well as growers owing to high sugar content early in the season and big tonnage ; can be milled from first week of December till mid-February ; susceptibility to mosaic stands in the way of its distribution at present though mills approve of the cane being released for general planting.

Co. 318 (Co. 229 SELFED)

Germination fair with earlier planting, otherwise slow ; bud viability high keeping till rains ; stand thick and uniform in most types of soil ; habit straight and erect ; stands drought splendidly, maintaining narrow, dark-green medium-abundant foliage ; tillering early and strong ; responds to rains quickly growing very vigorously thereafter ; borer slight mealy-wings occasional, mosaic in early stages pronounced ; stands water-logging successfully, eminently suited to *usar* conditions and submergence ; has recently shown flood resistance.

Medium thick cane ; rind very hard, fibre 16·2 per cent., pith slight, cavity pronounced ; joints 5·3 in., girth 3·1 in.; rooting uncommon, shooting late in the season, suffers if stopped in winter ; splitting occasional ; ripens about mid-February and maintains till April ; juice, however, is not very rich, but cane keeps without serious deterioration for some days ; ripens a month earlier in Orissa, flowers profusely since 1931 and sets viable seeds at certain places.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November . .	66·6	14·14	10·18	74·0	8·42
January . .	68·4	15·69	12·61	80·4	10·42
March . .	69·5	17·64	14·45	81·8	11·89
April . .	68·42	19·46	15·52	80·0	12·41

Root-system strong, penetrating and adaptive, roots as deep as 17·0 feet have been traced in light type of soil, strongly held and well branched.

Special condition cane, agriculturally good. chemically fair, can stand high storms and might serve as wind break to susceptible types ; likely cane for *usar* land where it shows excellent chemical performance ; is definitely early in Orissa giving superior juice, has shown encouraging growth in Chota Nagpur ; rather poor chemically on uplands in Bihar and is late.

Co. 326 (Co. 229 SELFED)

Germination slow, but sure; requires high soil-moisture content and early planting in the season to give good germination, stand good in heavy well-drained soils; habit spreading in early stages; later erect; stands through hot weather splendidly, maintaining medium-broad, dark-green, medium-abundant foliage ; tillers shyly in light soils, improving satisfactorily in heavier types; responds to rain quickly, grows vigorously in steamy weather; keeps beautifully upright during and after rains; cane stood very well heavy storm following heavy rainfall in 1931; borer very slight, yellowing and mosaic rare, tolerates *usar* to a high degree, rather doubtful under water-logged conditions.

Medium cane with upright habit; hard rind; fibre 16·6 per cent., cavity slight pithy in lowlands; joint 5·41 in., girth 2·95 in.; splitting absent; shooting rare; successfully maintains through cold weather, rather late, tops begin drying slightly towards the end of April; matures about March, after which undergoes deterioration; juice slightly richer in South Bihar.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	59·9	14·31	10·33	72·2	8·47
January . .	60·6	27·59	13·85	78·7	11·12
February . .	60·8	17·60	14·33	81·9	11·57
March . .	60·7	17·89	15·51	86·7	12·38
April . .	58·5	19·49	15·49	78·3	12·09
May . .	54·0	19·40	15·09	77·8	11·10

Root-system strong, penetrating and adaptive; roots have been observed to grow normally under high pH conditions, firmly held, possessing high tensile power.

Special condition cane, good grower through hot weather, is being tried in Shahabad, might replace Co. 213 in parts of Saran; agriculturally quite good, chemically mediocre with comparatively low net rendement.

Co. 330 (Co. 213♀ × Co. 214♂)

Germination fair to good, depending upon soil moisture at the time of planting; bud viability quite high; stand average habit spreading in early stages, later erect; grows successfully through hot weather maintaining medium-broad, dark-green, medium-abundant foliage; tillers strongly; responds to rains quickly and grows

fast, keeping erect during and after rains; borer slight, yellowing pronounced in *usar* patches; mosaic marked in early stages, susceptible to water-logging.

Thin to medium cane with upright habit; hard rind; fibre 14·4 per cent.; slightly pithy, but no cavity, swollen nodes, joint 4·54 in.; girth 2·64 in.; splitting occasional, shooting and rooting pronounced in wet year; maintains remarkably through cold weather with high residual soil-moisture; is a failure with scanty monsoon; matures end of December and maintains till end of May, keeps green tuft and looks cheerful, deteriorates rapidly on keeping.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November . .	57·5	15·24	12·03	78·9	9·83
December .	56·9	18·64	16·04	85·9	12·42
January . .	55·5	19·64	16·64	85·9	13·06
February . .	55·8	19·98	17·21	86·1	13·27
March . .	55·4	20·80	17·98	86·3	14·25
April . .	52·1	19·56	16·39	83·9	12·54
May . .	50·5	19·50	16·04	81·5	11·92

Root-system superficial, thickly branched, penetrating deep in summer; not recovering soon after rains; root mass functioning during cold months, pronounced flushing in early spring and heavy root mass at surface indicate ratooning power.

A very good grower in favourable monsoon; giving fair tonnage and juice of satisfactory quality maintaining through winter and spring, rather low extractions but might do better under irrigation.

Co. 331 (Co. 213♀ × Co. 214♂)

Germination very good and fast with high soil moitsure content, both germination and early growth in early-planted cane are excellent; very erect in habit; manages through hot weather, maintaining broad, dark-green, abundant foilage; suffers slightly during protracted drought; often develops pith and cavity during hot weather; is an excellent grower in favourable rainfall; under irrigated conditions shows up more prominently, tillers strongly at the advent of rains, responds spontaneously and grows very fast in steamy weather; keeps upright during and after rains; mosaic very rare; borer slight; yellowing in badly-drained soil, tolerates *usar* and water-logging to a considerable extent; recently shown flood resistance.

Medium thickish cane with up right habit; medium hard rind; fibre 14·1 per cent., cavity pronounced from monsoon onwards; younger joints occasionally pithy; joint 6·1 in., girth 3·34 in., splitting rare, shooting absent, rather late type maintaining very well during April and early May; matures about February in Tirhut, about end of March in Saran; rather early in Orissa and South Bihar, keeps very well on cutting.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
January . .	66·6	17·81	15·06	84·5	12·01
February . .	62·6	19·93	17·10	85·5	12·94
March . .	59·4	20·95	18·44	88·0	13·57
April . .	54·2	20·70	18·22	88·0	12·12
May . .	58·6	21·40	18·30	86·8	12·98

Root-system strong, penetrating and highly adaptive, thicky branched at surface during rains and deeply penetrating during summer, firmly held; growing satisfactorily under *usar* and water-logged conditions.

A very promising cane of remarkable habit; at its best on high lands in a favourable year; tends to be very late on good lands, in field trials has out-yielded Co. 213, giving as much as over 40 per cent. statistically significant increase; chemically satisfactory; the cane is expected to find favour with cultivators for high tonnage and with mill-owners for maintaining high purity and sucrose, rather late in the season; is being released for general planting as a definite purpose improved cane.

Co. 336 (Co. 214 SELFED)

Germination slow and gappy under low soil-moisture conditions, planting early in the season results in satisfactory germination; bud viability high, but suffering in flooded lands; habit straight erect, stand patchy in earlier stages, filling up fast with early showers; manages successfully through summer, maintaining narrow dark-green scanty foliage, tillers profusely with advent of rains when cane gets real "pick up" and makes fast growth; borer occasional in dry weather when side shooting markedly pronounced: tolerates *usar* but is susceptible to water-logging.

Thin to medium cane, almost upright, soft rind, fibre 13·4 per cent., pithy in a dry year, cavity rare; usually solid texture, joint 5·54 in., girth 2·68 in., splitting absent, shooting late in the season, rooting rare; very early cane worth milling end of

November, maintaining rich juice and high purity splendidly till May; keeps admirably, is now under trial against the other promising earlies; this cane has been planted out specially for studying its physiology and biochemistry under *usar* conditions where it grows very well, west of Gandak poor performance.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
November .	54·1	15·71	12·56	80·0	9·47
December .	60·5	17·52	14·52	82·9	11·74
January . .	58·5	18·21	16·23	87·9	12·69
February . .	57·2	17·61	14·65	83·2	12·04
March . .	55·6	18·04	15·04	83·3	12·27
April . .	58·0	18·50	15·73	85·0	13·04

Root-system strong and well adapted to unirrigated conditions; with its profuse and deep branching roots it can adjust itself to changing circumstance; detailed study of roots from physiological point of view is in hand.

An early cane, quite good chemically mediocre agriculturally; might prove suitable as early mill cane.

Co. 342 (Co. 281♀ × Co. 223♂)

Germination good, bud viability high, maintaining till rains or later; stand average; habit almost erect to upright later in the season, manages hot weather, maintaining medium-broad, dark-green, medium-abundant foliage; tillers strongly, responds to rains quickly and recovers splendidly during August when conveys cheerful and healthy look superior to most other earlies; stands upright during and after rains, does not tolerate *usar*, stands water-logging to a certain extent, yellowing pronounced under Saran conditions, stands comparatively free elsewhere in North Bihar, borer occasional, mosaic rare.

Medium cane, upright in habit; medium-hard rind, fibre 12·9 per cent.; solid texture, pith in dry year, cavity rare; joint 5·69 in., girth 3·10 in, splits badly shooting rare; gives good purity and sucrose at the end of December when it can be milled so that it comes in between the very early and mid-season varieties; gives significantly higher yield than Co. 214 and in end of December carries fair amount of

sugar ; maintains till February ; in a dry spring and under low residual moisture condition drops off ; flowers and sets seed in open to a limited extent.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent. on cane
November . .	62·9	17·26	13·66	79·2	10·82
December .	64·7	17·42	15·34	88·1	12·93
January . .	69·9	19·01	16·43	86·4	12·87
March . .	60·9	20·90	18·32	87·4	13·52

Root-system unirrigated type and penetrating, surface rooting heavy, thinly branched during rains, ends branched and functioning in hot weather, adaptive within limited range.

Quite an average grower agriculturally ; rather early, commanding a position in between the very early varieties and mid-season ones, carries sugar satisfactory enough and might become popular.

Co. 346 (Co. 281♀ × Co. 223♂)

Germination good under high soil moisture conditions, bud viability high ; stand best in favourable year and in heavy types ; habit spreading when young, erect later ; stands successfully through hot weather, maintaining medium-broad, green, medium-abundant foliage ; tillers strongly ; responds satisfactorily to rains' keeping erect during and after, late, suckering in September ; susceptible to *usar*, stands water-logging to a limited extent, mosaic rare, yellowing pronounced, borer occasional.

Medium thickish cane, upright in habit ; medium-hard rind, fibre 14·0 per cent., pith in immature joints at maturity, cavity absent ; joint 1·56 in., girth 3·41 in., splitting occasional shooting rare except late in the season ; matures in January, maintains till April, rather poor chemically under sepaya conditions in a humid year, does not keep, flowers profusely early in the season and sets freely in the open.

Month	Extraction	Brix	Sucrose	Purity	Sugar per cent on cane
December .	64·5	18·20	13·69	75·3	10·20
January . .	63·3	18·60	15·00	80·7	11·90
February . .	64·1	19·03	16·18	85·0	12·74
March . .	65·0	22·6	19·98	87·9	14·91
April . .	61·2	20·1	17·39	86·5	13·24

Root-system unirrigated type, penetrating, not adaptive; thick rooting at surface indicates ratooning power.

A good grower agriculturally and better than mediocre chemically, seems better suited to heavier soils, promising under conditions of South-East Bihar.

Co. 347 (Co. 281♀ × Co. 223♂)

Germination fair, bud viability high, stand fair to good in different soils; habit spreading or slant when young, erect later, stands through hot weather, maintaining medium-broad, green, abundant foliage which heavily droops at tips; tillers shyly in badly-drained soils, improving considerably in heavy well-drained ones; responds slowly to rains but makes tremendous growth in August and September; occasionally late suckering; tolerates adverse conditions of *usar*, waterlogging and drought to a certain extent, mosaic rare, borer occasional, preferred by white-ants.

Medium thickish cane with upright habit, medium-hard rind, fibre 13·8 per cent., slight pith, no cavity; joint 4·53 in., girth 3·46 in., splitting absent, shooting rare, maintains successfully through cold weather, flowers rarely, maintains green tuft, ripens about February, and maintains till April or later, much better sugar east of Gandak river.

Month	Extraction	Brix	Sucrose	Purity
December	69·1	12·70	9·54	75·10
February . .	70·6	12·89	10·69	82·7
March	67·0	14·84	12·26	82·6
April	67·0	16·33	13·66	83·6

Root-system deep, penetrating and adaptive to varying conditions of soil and moisture; strong root mass at surface and fast flushing under favourable conditions indicate ratooning power.

Quite promising both agriculturally and chemically, is being tried against standards at various farms in the province.

Co. 349 (P. O. J. 2725♀ × Co. 243♂)

Germination fair to good in soils of heavy texture; with high soil moisture and early planting germination better still; but viability rather low; stand fair, better in heavy lands, habit spreading when young, later straight erect; suffers from protracted drought though manages successfully in a favourable year under irrigation; tillers fast; responds slowly, "picking up" in the middle of monsoons, mosaic rare in early stages; borer occasional north of river Ganges, pronounced at Patna, requires clean culture conditions; resents bad drainage and *usar*.

Rather thick cane with upright habit, barrelled joints ; soft rind, fibre 11·8 per cent., pith and cavity rare ; joint 4·5 in., girth 4·26 in., splitting absent ; shooting rare late in the season ; does not flower and maintains green tuft in year of high rainfall ; early maturing under South Bihar and Orissa conditions, mid-season under conditions north of river Ganges, maintains till January but does not keep well on cutting

Month	Extraction	Brix	Sucrose	Purity
November	66·6	16·62	14·20	85·43
December	66·0	19·3	17·59	91·12

Root-system superficial, filling type with thick root mass at surface at maturity likely to prove a good ratooner.

Thick clean cane, low fibre, high sucrose early in the season ; might prove valuable as early and mid-season mill cane under South Bihar and Orissa conditions. In North Bihar its scope is rather limited ; jackal trouble might become acute owing to softness of rind.

In addition to the varieties described above the following varieties namely Cos. 297, 298, 311, 321, 322, 323, 324, 325, 327, 328, 329, 332, 333, 334, 335, 337, 338, 339, 340, 344, 345, 348, 350 were also under detailed observations for a number of years but have been rejected being unsuitable to conditions obtaining in Bihar and Orissa for reasons of either poor growth or low quality of juice. Co. 320 though poor agriculturally has a special value as a drought resisting type and is under study from the physiological points of view.

A NOTE ON THE SINDI HERD OF COWS MAINTAINED BY THE MADRAS GOVERNMENT

BY

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For the past twelve years a herd of Sindi cows has been maintained by the Madras Government. Formerly these animals were kept at the Agricultural College Dairy, Coimbatore. On the acquisition of the Hosur Cattle Farm in 1924, most of the cows and young stock were transferred to Hosur and further purchases of Sindi cows were made through the Imperial Dairy Expert. The foundation stock on the whole have been good and through selection and careful breeding a herd of good milking cows is being evolved. There is great demand for bulls of this breed and the present supply is not sufficient to meet it ; they are required to grade up the poor stock on the West Coast in Malabar and South Kanara Districts, for stud purposes in urban districts where the demand for milk is increasing and in planting districts where the planters are using these bulls on their cross-bred cows to breed back to the country type and to grade up the cattle belonging to the estate coolies. Bullocks of this breed are used for work purposes on some of the agricultural stations including two of the paddy breeding stations and are proving satisfactory workers.

It is found that this breed maintains good condition at Hosur and is a thrifty feeder. The stock born and reared on the Farm are a little larger in size than the foundation stock. Lately several well-developed young bulls of 22 to 24 months of age have been tested for service and found satisfactory but they are not issued for breeding purposes until they attain 2½ years of age.

The Sindi cow is one of the best for the small dairyman, it is not a large animal and it eats less food than the larger cows such as Ongoles, Sahiwals, etc., and is a thrifty feeder and maintains good condition on fairly scanty rations. Mr. Smith, the late Imperial Dairy Expert, wrote on this breed as follows :—

> " It is one of the purest and most distinct of Indian breeds of cattle ; it is, moreover, the only breed of commercially profitable dairy cattle in this country outside of buffaloes, which can be purchased in large numbers. "

The Buckingham and Carnatic Mills, Madras, in 1922, disposed of their Ongole cows and purchased a small herd of Sindi cows for their dairy and today they have a very good herd of milking cows of pure Sind breed. A few Sindi cows are found in the

seaport towns along the West Coast such as Mangalore, Calicut, Cannanore, etc. these have been brought down by shippers from Karachi and Bombay.

Bulls for breeding purposes from Hosur have been sold to the Imperial Institute of Animal Husbandry and Dairying, Bangalore and to Bengal, Cochin and Ceylon Governments.

At the present time a herd of 70 Sindi cows is maintained at Hosur and records maintained for each animal. The following particulars have been worked out up-to-date :—

Milk yields

The purchased foundation stock have averaged 3,572 lb. milk with a daily average of 11·9 lb. The farm-bred cows, including first calvers, have averaged 4,137 lb. with a daily average of 11·9 lb.

Eight cows have yielded over 6,000 lb. and 11 between 5,000 & 6,000 lb. of milk in a single lactation.

The average maximum yields of these are —

Foundation stock	4,416 lb., daily average 12·06 lb.
Farm-bred cows	4,467 lb., daily average 12·8 lb.

Of course the foundation stock have all reached their maximum whereas all the farm-bred ones have not, as first and second calvers are included. The average number of calvings is—

Foundation stock	4·5
Farm-bred stock	2·3

The number of days dry omitting abnormal cases of 300 days or more is—

	Days
Foundation stock	190
Farm-bred stock	158

Taking the whole herd, the cows have averaged 3,251 lb. milk in 309 days with a daily average of 10·5 lb. They have calved on the average every 16 months.

A large number of the farm-bred cows have and are producing good yields of milk in their first lactation ; several of them are giving 20 to 22 lb. milk per day at the maximum. One heifer No. 43 has given in her first lactation 7,718 lb. with a daily average of 17·7 lb. and cows 40 and 42 have yielded over 5,200 lb. in their first lactation. The maximum daily yield recorded is 34 lb. (cow No. 232).

Yields of some of the best performers

Cow No.	No. of calvings	Average milk yield	Average daily average	Maximum milk yield	Daily average
		lb.	lb.	lb.	lb.
25	5	5,649	16·9	6,861	17·5
228	2	4,934	15·4	6,590	17·6
230	3	4,631	15·9	5,081	15·9
232	3	5,899	14·9	6,639	15·8
236	2	5,031	16·6	5,271	12·7
238	3	4,821	12·8	5,203	13·6
244	4	5,077	14·4	6,210	15·8
38	4	4,346	13·2	5,036	14·0
144	6	4,294	12·6	5,023	12·6
160	5	4,027	13 0	5,051	14·1
5	2	5,599	16·3	6,095	17·2
9	1	4,733	11·6	4,733	11·6
12	2	4,669	13·8	4,961	15·1
145	6	4,233	12·0	5,979	14·8
180	6	4,084	13·3	6,041	18·3
218	3	4,927	10·7	5,302	14·1
24	2	4,663	12·6	4,663	12·6
33	1	4,810	12·5	4,810	12·5
40	1	5,216	13·8	5,216	13·8
42	1	5,231	15·7	5,231	15·7
43	1	7,118	17·7	7,118	17·7
49	1	4,929	14·7	4,929	14·7

WEIGHTS

The average weights of calves at birth are—

Bulls . . . . 47 lb.

Heifers . . . . 42 lb.

The average weights of adult stock are—

Bull . . . . 950 to 1,000 lb.

Cow . . . . 650 to 750 lb.

Fig. 1. Scind bull No. 65, age 3 years ; dam's best yield 6210 lbs.

Fig. 1. Scind cow No. 15, milk yields 3782 lbs., daily average 12·3 lbs.; 6289 lbs., daily average 17·3 lbs.

ERRATA.

Agriculture and Live-stock in India, Vol. V, Part III.

Contents—line 4, put a comma after the word "**Research**".

Page 251, line 6—*For* "WHEATI PRCES" *read* "WHEAT PRICES".

Page 284, under Lyallpur, against August 27th, below *Maghar*, *for* "2 3 3¼" *read* "2 3 3¾."

Page 288, heading of column 5, *for* "*Chhauni*" *read* "*Chhanni*".

Page 315, heading, *for* "REVI WS" *read* "REVIEWS".

Page 324, under FRUITS, after item 89 *insert* items 90 and 91.

EXPLANATION OF PLATE.

FIG. 1. Shows the view from below of the surface of cleavage (A) and origin of adventitious roots of mature water-hyacinth seedling which floated up after 24 hours of submersion. Inset—the surface of cleavage B of the root-stock left behind in the mud. The root-stock was pinned to a cork and photographed.

FIG. 2. Shows four seedlings collected in the field which had floated up after submersion. A number of adventitious roots are seen coming out, and the lower leaves are bent down. Nat. size.

Fig 1 Scind cow No 232 milk yields 5160 lbs daily average 14 1 lbs 6639 lbs daily average 15 8 lbs 6431 lbs daily average 16 6 lbs (maximum daily yield 34 lbs)

Fig 2 Scind cow No 228 milk yields 6590 lbs, daily average 17 6 lbs 5523 lbs daily average 17 5 lbs

FIG. 1 Scind bull No. 38, age 4½ years dam's best yield 5979 lbs.

FIG 2. Scind bull No. 56, age 3½ years , dam's best yield 6639 lbs.

THE CONDITION OF THE UPPER INDIA SUGAR INDUSTRY IN RELATION TO BORER INFESTATION AND DISEASE INFECTION

BY

NOEL DEERR

During the past few years it has been the custom of Messrs. Begg Sutherland & Co., Ltd., to hold a conference of their senior officers shortly before the harvest season of the sugarcane crop begins. At this conference expressions of opinion on matters connected with the work of the officers are requested.

At the last meeting held in October 1934, the opinion was freely expressed that the Co. canes had "deteriorated" both as regards field outturn and sugar content. The present writer, while agreeing that the yield and sugar content presented indications of failing, took exception to the use of the term "deterioration" and adopted the attitude that an asexually propagated plant could not for this very reason deteriorate. He referred to a considered opinion he had given on this question fifteen years ago when discussing degenerescence of the cane as a contributory factor to the epidemics of disease of which the history of the sugarcane affords many examples. His opinion from which he sees no reason to depart is quoted below[1] :

> "Degenerescence is often given as a cause of these epidemics, but the writer in the position of a layman regards the explanation as unrational. What is in all probability one and the same cane (Otaheite) has been the subject of most of the epidemics referred to above. During the time 1848-51 that the first Mauritius epidemic occurred, this cane was flourishing in the West Indies, and a few years later was introduced to the Hawaiian Islands with remarkable success. Excepting the possible presence of adventitious seedling descendants, each and every cane then growing must have been the progeny in unbroken asexual descent of one cane, which probably originated as a seedling in some island of Polynesia, probably Otaheite, and, to go further, all the then existing canes may be regarded strictly as one and the same individual. Looked at in this light, degeneration as the result of age, or as the result of continued propagation from cuttings, appears ill-founded, and the epidemics were more likely to have been due to improper agriculture leading to harmful soil conditions, combined possibly with the development of an organism or organisms of a virulent strain due to long-continued access when the cane once formed the sole crop of a locality".

[1] Cane sugar, p. 155.

Statistics, which have been carefully kept over the past twleve years as part of the routine of sugar production control, do distinctly indicate a progressive fall in sugar content over the past six or seven years and in support of this statement in Table I is presented the sugar content of the cane for the month of January at each of the factories operated by Messrs. Begg Sutherland & Co., Ltd., and while it is known that the influence of the quantity of direct sun light, of rainfall and its distribution are important factors, there seems to be some other factor at work.

A study of other possible causes however showed a distinct correlation between the introduction of new varieties and of an extension of planted area with an increment in sugar content. The matter continued to engage the writer's attention and early in January he was asked by Mr. Campbell, the Manager of Ryam Factory, to inspect some dirty and rooted cane tendered for sale. It occurred to him to make a thorough inspection of the cane and he ordered the contents of the cart to be split lengthways, stick by stick. On examination it was found that a great proportion of the cane was borer infested and showed at the same time indications of infection with disease. Similar results being obtained at Purtabpore, the writer considered the matter so serious and menacing that he ordered a detailed survey of the cane at the eight factories operated by Messrs. Begg Sutherland & Co., Ltd., and at the same time called the attention of Government to the conditions.* The result of the survey is given in the Appendix and as a result of this survey, combined with an examination of statistics of record, the writer feels justified in making the following statement :

1. The sugarcane crop in Upper India is heavily infested with various species of moth borer.
2. Associated with the wound injury, opportunity is afforded for the entry into the plant tissues of micro-organisms responsible for the destruction of large quantities of sugar.
3. Apart from infection following on wound injury, there exists evidence of an infection of the crop which may possibly be transmitted from infected seed cane.†

* It is unfortunate that writing hurriedly, I inadvisedly referred the loss to the miller to infection by the fungus *Colletotrichum falcatum* and allied fungi following on infection of the cane after wound injury due to borer. It now appears that borer is the dominant factor and that the loss of sugar is due to invasion of the plant tissues by bacteria, yeasts and fungi of which *Coletotrichum falcutum* (the specific cause of the disease red-rot) may be one but which is not present in dominant number. At the same time while it was evident that borer was the primary cause followed by the consequent exposure of the tissues to micro-organic invasion there also appeared much evidence pointing to a widespread infection independent of borer injury and which may perhaps be transmitted from infected seed cane to the following crop.

† The most common evidence was a yellowish colouration of the parenchyma which seemed similar to the illustrations given by Butler of collar-rot and of cane wilt. Much less frequently a red discolouration with the white patches symptomatic of red rot were observed. These conditions affect whole canes in the absence of borer injury The juice from the material was invariably of low sugar content and averaged from 60—70 purity. A count was made of over 3,612 seers of cane at Marhowrah where it was found in 151 seers or in 4·2 per cent.

4. The types of cane now grown in Upper India appear to be tolerant to borer damage in the sense that in the presence of an extensive infestation, normal growth and remunerative crops can be obtained.
5. Although attention is now specifically called to this condition of borer infestation, the evidence does not point to the present year being one of abnormal infestation. It would appear rather that the condition of infestation is one of gradual increment and that the borer follows the extension of cane plantings to areas, which, when first planted, are free from the pest.
6. In the absence of a fulminant outbreak of borer and of any peak in the incidence of the pest, there is danger of discounting the damage and of regarding it as a constant and uncontrollable overhead charge.* This attitude is likely to be encouraged by the impossibility of differentiating between sound and infested cane except by a detailed examination entailing the splitting lengthways stick by stick of a parcel of canes.
7. The annual loss due to borer reaches very large sums which fall in part on the grower and in part on the miller. One determination only (*see* Schedule III) indicated in an exceptionally fine crop a loss due to mechanical injury of 8 per cent. of the weight of the crop which falls entirely on the grower. The average of eight surveys indicates a loss to the miller of 800 mds. of sugar per 1,00,000 mds. of cane. Accepting that the cane milled in factories, this year, over all India will be fifteen crores of maunds, the loss in weight of standing cane will be 1·2 crores of maunds of value, at 5 annas per maund, of 37·5 lakhs of rupees The loss of sugar on cane actually milled will be twelve lakhs of maunds of value, at Rs. 8 per maund, of 96 lakhs of rupees. The total of these amounts to one crore and thirty-three and a half lakhs of rupees. It is not pretended that the survey upon which these figures are based is complete, but an estimate of damage amounting, annually, to a crore of rupees is probably below above the mark.†

* What I take to be an unreasonable attitude was put before me in a discussion. The statement was made that as the yield at a certain factory dealing with heavily infested cane was only a little below normal that factory had no cause for complaint. This is quite without the main question. The loss is the same whatever the yield and indeed one factory included in the survey with a yield well above average presents a much greater loss due to borer infestation.

† This estimate does not take into accountthe condition in the Western U. P. where damage not only from borer, but from Pyrilla is reported as serious. Pyrilla, while present in the Eastern U. P. and in Bihar, has only once been seen by the writer in quantity in the area covered by his survey. This was at Purtabpore on the boundary between Bihar and the United Provinces.

8. Apart from the loss to the miller, the question has a national aspect in so far as the Excise and Imperial Revenues suffer from the depleted yield. On the figures quoted above, this loss may be put down as amounting to twelve lakhs of rupees annually.

What the writer believes to be an unbiassed view of the situation has been presented above. Independent of the annual overhead loss, the magnitude of which, the writer believes, has not up to the present received recognition, the uncontrolled infestation of the standing crop of cane by borer constitutes a permanent menace to the stability of the industry in which, apart from both grower and miller, Government has a stake. In the history of the cane sugar industry all the world over there are records of " diseases " suddenly appearing in a fulminant form. The epidemics have been associated with a " degenerescence " of the cane previous to the epidemic. The writer regards this degenerescence as evidence of the gradual infection of the crop with disease organisms which, when afforded a continuous habitat, in course of time acquired a virulent character resulting in an epidemic. In India the conditions are favourable for what has happened in the past to happen again. Of seed selection and nurseries, for the growing and distribution of clean sound seed, there is a deficiency compared with the magnitude of the industry. Due to borer infestation, disease organisms have a continuous habitat and the work of Butler [1917] has shown that pathogenic fungi specifically associated with the cane are not absent. It would then appear that a case for entomological research and the energetic application of the result of research has been made out.

The life-history of the moth borer as it occurs in Western India has been described by Lefroy [1906] many years ago and although much may have been added to the store of knowledge since, perusal of this paper will show how much still remains to be done. This paper gives a resume of methods of control and reference to it will indicate how inadequate its late distinguished author regarded them. The writer makes no pretence to specialized entomological knowledge ; he realises the magnitude of the problem, its difficulties and particularly those due to the conditions peculiar to the decentralized system under which cane is grown in India. It was, however, his good fortune to have worked in Hawaii during the period of the spectacular and eminently successful work done by Koebele, Perkins, Muir and their associates in the introduction of parasites of pests forming the natural method of control. A system which has been successful in a highly organised industry confined to narrow insular limits need not necessarily have the same degree of success when transferred to a continental area where the methods of agriculture and the efficiency of organization are remote from those where the principles of the natural method of control were triumphantly vindicated. Nevertheless the constant loss is so pronounced and the possible benefit so great that it would be wrong not to consider this method and to give it a detailed and long continued trial whatever the difficulties and however remote may be thought the prospects of success.

As I have already written Government is deeply interested in the development and well-being of the sugar industry. It is a partaker in its profits and may even be regarded as a shareholder. Government has undertaken to devote a portion of the funds coming from the Excise to the sugar industry and it is suggested that here lies an opportunity for an investment of these funds which will not only react to the benefit of the industry but will at the same time increase the industry's contibution to the Imperial Revenues.

REFERENCES

Butler, E. J. (1917). Plant Diseases and their Remedies, Calcutta.
Lefroy, M. (1906). *Agric. J. Ind.*, **1**, 97.

TABLE I

Average sugar per cent cane in factories operated by Messrs. Begg Sutherland & Co., Ltd for the month of January and for the years 1924 to 1935.

Year	Bal-ram-pur	Barra	Chan-patia	Gauri	Mar-how-rah	Pur-tab-pore	Ryam	Sama-stipur	Ave-rage
1924 . . .	..	11·3	..	9·6	12·1	11·7	11·4	11·3	11·2
1925 . . .	..	10·7	..	10·3	11·7	10·8	11·4	11·1	11·0
1926 . . .	..	11·3	..	10·0	11·0	10·6	10·1	11·4	10·7
1927 . . .	..	11·9	..	10·3	11·8	11·8	11·3	11·7	11·4
1928 . . .	..	11·7	..	10·0	11·7	11·7	11·0	12·0	11·2
1929 . . .	..	11·3	..	11·2	11·4	11·7	10·8	11·5	11·3
1930 . . .	..	10·8	..	11·2	11·1	10·8	11·2	11·2	11·0
1931 . . .	..	11·3	..	11·3	11·4	10·8	11·5	11·8	11·3
1932 . . .	..	11·2	..	10·6	11·0	10·9	11·4	12·0	11·2
1933 . . .	..	10·6	11·8	10·8	11·5	11·3	11·0	10·7	11·1
1934 . . .	11·4	11·3	11·2	11·8	11·9	11·4	11·2	11·2	11·4
1935 . . .	12·0	11·0	11·7	11·3	11·1	11·3	10·7	11·0	11·3
Average . . .	11·7	11·3	11·5	10·7	11·5	11·2	11·1	11·3	11·2

Appendix

Result of a survey of the condition of sugarcane crop in Bihar and the United Provinces with reference to borer infestation

The survey was made over the supplies of cane delivered to the eight factories, the operation of which is controlled by Messrs. Begg Sutherland & Co., Ltd. These factories are Balrampur, District Gonda; Gauri Bazar, District Gorakhpore; Purtabpore, District Gorakhpore and District Saran; Marhowrah, District Saran; Barrah Chakia and Chanpatia, District Champaran; Ryam and Samastipur, District Darbhanga. From east to west these factories are spread over a distance of 300 miles and from north to south of about 100 miles covering an area of about 30,000 square miles. The area supplying cane to these factories is about 100,000 acres, mainly in small plots.

The examination of the cane was made at the factories and every precaution was taken to make the survey representative, (*a*) of the areas whence supplies of cane were drawn, (*b*) of the material delivered. The survey was made by the factory staffs acting under general instructions given by the writer. In order to familiarise the staffs with the object of the survey the complete contents of carts were subjected to examination. Afterwards the inspection was restricted to parcels of 100 sticks taken from a cart or from a railway waggon. The method of inspection followed was to split the sticks of cane lengthways and to divide the material into sound and borer infested portions. These latter included cane which, while not showing evidence of actual wound injury from borer, presented symptoms of disease as shown by the presence of discoloured fibre. A count of the relative frequency of borer infestation and of symptoms of disease in the absence of wound injury was not made. Roughly, however, of the unsound cane, 90 per cent was distinctly due to borer damage and 10 per cent was apparently infected with disease in the absence of mechanical damage. After the separation was complete, the two portions were weighed and subjected to analysis. The analysis included the determination of solids, sugar and purity in the juice expressed by a hand mill. From these analyses passage to the composition of the cane and to the yield in the factory was made by the use of the expressions :—

Sugar per unit cane $= s = p[1-(f+\cdot 4 f)]$, where p is the polarization of the juice and f the fibre in the cane.

For sound cane a value of $0\cdot 15$ was accepted for f and of $0\cdot 175$ for infested cane.

The expression above then reduces to—

Sound cane	$s=0\cdot 790\ p$
Infested cane	$s=0\cdot 755\ p$

To determine the yield in the factory a mill extraction of $\cdot 94$ was taken for sound cane and of $\cdot 93$ for infested cane.

In both cases a virtual purity in waste molasses of ·35 was taken whence the following expressions result :

Sound cane——Yield per unit cane $= \cdot 94s(j - \cdot 35)/j(1 - \cdot 35) = 1 \cdot 45s(j - \cdot 35)/j$

Infested cane——Yield per unit cane $= \cdot 93s(j - \cdot 35)/j(1 - \cdot 35) = 1 \cdot 43s(j - \cdot 35)/j$

where j is the purity of the expressed juice.

A tabulation of the results of the survey follow.

Schedule I gives the average of the daily determinations as made at Ryam factory. This serves to show the variation in infestation over a district. It covers the cane supplied locally by cart and from seven stations on the Darbhanga-Sitamarhi branch of the B. & N. W. Rly. Schedule II gives the average results of the survey as made at the eight factories controlled by Messrs. Begg Sutherland & Co., Ltd., and in addition to local supplies covers the areas given below :

Balarampur.—Stations on the Gorakhpur-Gonda loop line of the B. & N. W. Rly. from Gonda to Pachpera and from Maskunwa to Colonelganj on the main line.

Gauri Bazar.—All local cane.

Purtabpore.—Stations on the main line of the B. & N. W. Rly., from Tahsi·Deoria to Bhatapokar and from Thawe and Jalalpur on the Gorakhpore-Sivan loop

Marhowrah.—All cane local.

Barra Chakia.—Stations on the Samastipur-Narkatiaganj branch of the B. & N. W. Rly. from Silout to Bettiah and from Ramgarwah on the Sagauli-Raxaul spur.

Samastipur.—Stations from Silout to Nayanagar and from Hayaghat to Begu Sarai.

Chanpatia.—Stations from Bagaha to Sikta on the Samastipur-Bagaha loop of the B. & N. W. Rly., from Narkatiaganj to Bettiah on the Samastipur-Narkatiaganj branch and from Gunaha and Amolwa on the Beknathoree spur.

Ryam.—Stations from Bairagnia to Kishanpur on the Samastipur-Narkatiaganj loop of the B. & N. W. Rly.

Schedule III gives the result of a survey made of a field of cane at Dowlatpore.

During the course of the survey the following observations were made ·

1 The infestation seems to be fairly uniformly distributed as between top stem and root borer.

2. In well cultivated cane, in the presence of extensive borer infestation, crops much above the Indian average may be obtained. An instance of this condition is to be found at Dowlatpore where one of the best crops in Bihar and cutting out at about 800 mds. per acre was found to be infested in 19·5 per cent of the internodes. Notwithstanding the satisfactory yield the damage is just as real as if the outturn was below normal.

3. Compared with what the writer remembers of the effect of borer damage on noble canes, the Co. canes seem resistant to or perhaps tolerant of borer injury. Cane of normal height and appearance was frequently seen with as many as twenty-five per cent of the internodes borer damaged often to the almost complete destruction of the parenchyma in the infested internodes.

4. In the case of top borer damage in well tended crops the upper buds sprouted and normal growth followed.

5. In the majority of cases, the node formed a barrier preventing the spread of infection of micro-organisms from one internode to those adjacent. In some cases this barrier was not effective.

6. Instances were observed of a widespread pathogenic condition independent of borer injury. These canes often presented a parenchyma of a yellowish red colouration with or without the presence of red streaks. In appearance these canes corresponded with the illustrations representing the appearance of collar-rot and of wilt given by Butler. Less frequently, a red discolouration associated with transverse white patches and symptomatic of red rot were observed. The writer suggests that these pathogenic conditions are ones which can be transmitted from seed cane to growing crop.

7. The external appearance of a field or of individual canes is no criterion of the extent of borer infestation. Well grown fields of cane on examination some times showed a greater incidence of infestation than did poorer fields in the immediate neighbourhood.

SCHEDULE I

Survey of borer infestation at Ryam

Sound cane							Infested cane.						
Weight Srs.	Per cent	Solids (Per 100 expressed juice)	Sugar (Per 100 expressed juice)	Purity	Sugar (Per 100 cane)	Yield (Per 100 cane)	Weight Srs.	Per cent	Solids (Per 100 expressed juice)	Sugar (Per 100 expressed juice)	Purity	Sugar (Per 100 cane)	Yield (Per 100 cane)
86	87	18·0	15·2	84·8	12·0	10·1	13	13	9·5	6·9	78·7	5·2	3·9
58	53	17·7	14·6	83·0	11·5	9·8	34	37	10·2	5·8	56·9	4·4	3·4
66	59	17·0	14·1	82·8	11·1	9·3	46	41	12·0	7·0	51·8	5·3	3·0
97	69	17·1	14·6	85·5	11·5	9·9	44	31	12·0	7·0	58·3	5·3	3·0
372	86	17·8	15·0	83·3	11·8	9·9	62	14	11·0	7·0	83·6	5·3	3·4
480	90	16·9	14·0	82·8	11·0	9·2	55	10	11·5	7·6	65·6	5·7	3·8
101	78	17·2	14·2	82·5	11·2	9·4	29	22	13·5	8·8	65·2	6·5	4·3
71	81	17·3	14·2	82·0	11·3	9·4	29	29	12·0	7·8	65·0	5·9	3·9
166	83	18·7	15·3	81·8	12·1	10·0	33	17	14·8	8·4	56·7	6·3	3·4
80	80	18·6	15·9	85·5	12·6	10·7	20	20	15·4	11·2	72·7	8·5	6·4
88	80	17·5	14·7	84·0	11·6	9·7	22	20	12·6	7·9	62·6	6·0	3·8
146	75	16·9	15·0	88·7	11·8	10·4	54	27	13·8	9·6	69·5	7·2	5·0
320	85	16·9	13·9	82·0	11·0	9·1	57	15	11·8	7·4	62·6	5·6	3·6
66	83	17·6	14·4	81·8	11·4	9·4	14	17	14·0	9·8	70·0	7·4	5·3
70	74	18·0	14·8	83·2	11·7	9·6	25	26	12·4	8·8	78·0	6·6	5·2
84	82	18·8	15·8	84·0	12·5	10·5	18	18	14·4	10·4	72·2	8·6	6·2
69	67	17·6	15·1	85·8	11·9	10·2	24	33	12·1	7·8	64·8	5·9	3·9
296	75	18·0	14·8	83·3	11·7	9·8	96	25	13·2	9·2	69·7	7·0	4·5
2,400	79	17·6	14·7	83·5	11·6	9 8	643	21	12·6	8·1	64·5	8·1	4·0

Average of all material

Weight Srs.	Per cent	Solids (Per 100 expressed Juice)	Sugar (Per 100 expressed Juice)	Purity	Sugar (Per 100 cane)	Yield (Per 100 cane)							
3,043	100	16·7	13·3	79·5	11·5	8·6	...	...	...	...	...	...	...

Schedule II

Survey of borer infestation at factories operated by Messrs. Begg Sutherland & Co., Ltd.

Factory	Sound material					Infested material					All material				
	Weight	Per cent	Purity	Sugar yield Per 100 cane		Weight	Per cent	Purity	Sugar yield Per 100 cane		Weight	Per cent	Purity	Sugar yield Per 100 cane	
Balarampur	845	99	83·5	12·5	10·5	5	1	70·0	10·0	7·1	850	100	83·4	12·5	10·4
Barra	12,294	85	83·1	12·5	10·5	2,256	15	66·1	6·8	4·6	14,550	100	80·5	11·6	9·6
Chanpatia . . .	450	78	84·9	13·0	11·1	125	22	71·0	7·5	5·5	675	100	82·1	11·8	9·9
Gauri	1,083	95	82·0	12·0	10·0	57	5	68·0	9·5	6·6	1,140	100	81·4	11·9	9·8
Marhowrah	3,189	88	85·5	14·0	12·0	430	12	70·0	7·4	5·3	3,619	100	81·8	13·2	11·2
Purtabpore	5,463	85	83·3	11·5	9·7	697	15	76·2	8·8	6·8	6,160	100	81·6	11·1	9·3
Ryam	2,400	79	83·5	11·6	9·8	643	21	64·5	8·1	5·3	3,043	100	79·5	11·0	8·8
Samastipur	524	70	82·6	12·2	10·2	223	30	73·5	10·5	8·6	747	100	79·6	11·6	9·7
Average . .	26,248	85	83·5	12·4	10·6	4,836	15	68·7	8·3	6·2	31,084	100	81·2	11·8	9·8

Schedule III

Borer infestation at Dowlatpore

Number of canes examined . . .		1,065 = 100·0
Number of canes wholly sound . . .		171 = 15·9
Number of canes infested		894 = 84·1
Number of internodes		17,146 = 100·0
Number of infested internodes . . .		3,344 = 19·5
Number of sound internodes		13,802 = 80·5
Weight of cane examined	(mds.) . .	29·8 = 100·0
Weight of wholly sound canes	„ . . .	5·2 = 17·5
Weight of infested canes	„ . . .	24·6 = 82·5
Weight of sound canes	„ . . .	26·1 = 87·5
Weight of infested canes	„ . . .	3·7 = 12·5
Weight of 100 internodes of sound cane	(srs.)	7·56
Weight of 100 internodes of infested cane	„	4·13
Weight of cane if wholly sound	(mds.) . .	32·4 = 100·0
Loss in weight due to borer	„ . .	2·6 = 8·0

Sound material—Sugar 12·2 per cent—Purity 83·9—Yield 10·3
Infested material—Sugar 10·1 per cent —Purity 69·0 –Yield 7·1
All material—Sugar 12·0 per cent—Purity 82·5—Yield 9·9

It is of interest to note the difference in weight per internode as between sound and infested material. The data obtained here indicate a loss to the grower of 8 per cent independent of any loss due to cane which may not have survived the attack of borer or which may have been arrested in development.

A NOTE ON THE ONGOLE BREED OF CATTLE

BY

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This breed is regarded as a dual purpose one. The bulls are used for work purposes in most of the districts, north of Madras, as far as Vizagapatam, Kurnool and Bellary districts and the cow is one of the chief sources of the Madras City milk supply. From enquiries made, it is estimated that about 2,500 cows of this breed are imported into the Madras City each year from the breeding tract, some are returned to the tract again when dry and others are sold to the butchers. The Ongole cow yields on the average about 2,500 lb. milk in a lactation in Madras. The Ongole Cattle Farm was opened in 1918 for the purpose of building up a pure herd of these animals which would calve regularly, produce good bulls for breeding purposes in the district and cows with a good average milk yield. In the beginning 48 cows were purchased from the breeding tract. Some were disposed of at different periods for various reasons and the number was reduced to 25. During the last ten years, particulars have been worked out regarding the milk yield of the selected foundation stock and their progeny with the following results.

I. The average yield of milk of the various classes :—

	lb.
(*a*) Foundation stock	2674·1
Daily average.	9·8
(*b*) Farm-bred cows with over 2 lactations	3526·4
Daily average	11·5

Farm-bred show an increase of 852 lb. milk in a lactation with a daily average increase of 1·7 lb. per cow.

The average yield of farm-bred stock, even including cows with one or two lactations, is 3,251 lb. and a daily average of 10·5 lb.

II. The average maximum yields are as follows :—

	lb.
(*a*) Foundation stock	3,714
Daily average	11·6
(*b*) Farm-bred cows (over 2 lactations)	4,047
Daily average	12·6

Farm-bred show an increase of 332 lb. milk with a daily average increase of 1 lb. per cow.

III. The highest individual yield in a lactation is :—

	lb.
(a) Foundation stock	5,422
Daily average	14·1
(b) Farm-bred cows	7,191
Daily average	21·5

On this Station 10 cows have yielded over 5,000 lb. milk in a single lactation, and 12 cows have yielded between 4,000 and 5,000 lbs. milk in a single lactation.

IV. The best average milk yield in each class is :—

	lb.
(a) Purchased cow	3,761
Daily average	11·5
(b) Farm-bred cows (4 in number) .	5,682 lb., daily average 17·1 lb.
	5,714 lb., daily average 16·1 lb.
	5,258 lb., daily average 14·0 lb.
	5,361 lb., daily average 13·7 lb.

V. The average dry period omitting abnormal cases :—

	Days
Foundation cows	177
Farm-bred cows	147

VI. The average age at which heifers calve on the Farm is 3 years 4 months and in the district 4 to 4½ years. The average weights of the calves are :—

	lb.
Bull calves	65½
Heifer calves	60

In April 1932, 38·2 Ongole cows at the Chintaladevi Livestock Research Station averaged 14 lb. milk per day per cow for the month.

VII. The average number of calvings for 15 old cows (15 to 17 years of age) is 8·5. Milk yields in general show an increase from the third lactation onwards, five cows gave their highest yields in their seventh lactation and three in their fifth. On the average a calf is produced every 16 months.

The female stock in the district is much neglected and usually takes the last place as regards feeding and attention. For instance, a ryot devotes his special attention to his work cattle, next to these come his bull calves which he is rearing next the cows suckling bull calves and lastly his dry cows and heifers.

The rearing of Ongole dairy heifers is generally in the hands of the poor class, chiefly *Malas ;* these people are usually the field labourers and weavers as well. They select one or two promising heifer calves from the ryot's herds, two to three months after they are weaned, generally at the age of about 12 months. The system of purchasing is usually, the *Mala* selects a calf and either purchases it outright, or

on stipulation such as face value plus a certain amount of the profit when the animal is sold, or the family agrees to do a certain amount of work at the time of the cultivation season for the ryot. The calf is reared carefully and generally attended to by all the members of the family, the number of calves reared vary with the size of the family. The females collect grass in their spare time or obtain fodder from the ryot as part wages whilst returning from work. A sufficient quantity is collected and stored in the harvest season when they assist the ryots in harvesting. This is supplemented with grass which is collected. It is fed in small quantities regularly along with some *Variga Pottu* (grain husk) and the washings from the kitchen. The heifers come to heat through good and regular attention from the age of 30 months and onwards. Promising animals pass several hands with a little profit to each. As soon as the *Mala* sells, he goes and purchases another animal with the money. In some cases these people walk many miles in search of a good heifer. When the animals are nearing parturition, they are purchased outright by dealers and when a sufficient number are procured, they are sent to Madras as milch animals. Some of these after they go dry in Madras are sent back to the district again to be maintained until they calve again. The maintenance charges one or two years ago were from Rs. 6 to Rs. 8 per month and a turban or cloth was given to the *Mala* when the animal calved and was taken back.

The Ongole cattle on the whole have poor horns and they have not a characteristic shape like breeds such as the Kangayam and the Mysores. Amongst the work cattle in the tract itself all sorts and sizes of horns are seen. The horn in the bull is short and stumpy and in several instances it is inclined to be slightly loose but is not noticeable until shaken by the hand. Several experts have been consulted regarding this but they are not able to throw any light on the subject ; the late Imperial Dairy Expert (Mr. Smith) stated that loose horns are common in the Hariana and Kistna Valley breeds of cattle and these are very similar in type to the Ongole and he concludes that this is due to years of domestication. Loose horns are very common in the Sahiwal breed of cattle also. In any case both in his and the writer's opinion, this is a minor fault if the cow is otherwise of the proper type, a regular breeder and a good average milker. In the west in judging animals, little or no notice is taken of the horn. In judging the scale of points one mark is allotted for horns out of 100. Loose horns have been noticed in some of the Ongole heifers at Hosur at the age of 2 years and they have become tight at the age of 3 to 3½ years.

The average weight of an Ongole cow is about 900 lb. to 1,000 lb. and a bull from 1,200 to 1,350 lb. A fully-grown bull of good size will weigh about 1,500 lbs.

The height of a good bull behind the hump is about 60 in. and at the croup 61 in. the girth measurement is 80 to 85 in. and the length from the top of the shoulder blade to the buttocks is 64 to 69 in.

The height of an average cow is 52 in., the girth measurement 68 in. and the length 53 in.

The fat percentage of the milk averages from 4·5 to 5·8.

FIG. 1. Ongole cow No. 107, milk yields 4965 lbs., daily average 13.5 lbs.; 5026 lbs., daily average 17.4 lbs.; 6687 lbs., daily average 17.6 lbs. (Gave at its maximum 33½ lbs. per day record.)

FIG. 2. Ongole cow No. 148, milk yield 4890 lbs., daily average 20.6 lbs.

Fig. 1. Ongole bull No. 12[illegible]

TABLE I

Yields of the best cows

Cow No.	Age (years)	Number of calvings	Average milk yield	Average daily average	Maximum milk yield	Average number of days
			lb.	lb.	lb.	
2 . . .	14	9	3,226	11·1	5,422	213
25 . . .	15	8	3,761	11·5	5,351	216
33 . . .	15	9	3,384	10·6	4,358	129
13 . . .	11	7	2,934	11·9	4,723	118
57 . . .	12	5	3,238	10·0	4,504	172
78 . . .	10	5	3,326	9·9	4,142	213
71 . . .	11	5	4,070	12·9	4,779	137
79 . . .	10	4	3,717	11·2	4,156	335
87 . . .	9	5	3,746	10·8	4,008	116
95 . . .	6	3	5,682	17·1	7,190	140
100 . . .	8½	4	4,340	14·5	5,421	261
101 . . .	8½	4	4,660	14·1	5,355	133
107 . . .	6	3	5,714	16·1	6,687	149
109 . . .	8	3	4,485	13·5	5,295	195
111 . . .	8	4	4,838	16·3	5,205	161
116 . . .	7	3	3,489	12·9	4,251	143
133 . . .	6	2	4,408	13·1	4,873	208
93 . . .	7	3	3.935	12·1	4,877	156
119 . . .	5½	1	4,330	11·2	4,330	..
120 . . .	5½	2	5,236	12·9	5,236	167
148 . . .	5½	2	4,890	20·6	4,890	265
191 . . .	5½	2	5,361	13·7	5,361	66

THE PROBLEM OF WHEAT PRICES*

BY

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Dehra Dun

The Royal Commission on Agriculture admitted that agricultural marketing was a closely guarded secret which its researches were not able to penetrate. But though the Commission stressed the necessity of systematic surveys, it was not until the catastrophic fall in prices of grain began in 1930 that any attempts were made. These efforts being far from comprehensive, marketing remains an arcana which must be mastered in the interests of agriculture.

The marketing of wheat is probably most important and certainly most complex. It is important because wheat is a commercial crop of great value in northern India, to which the prices of other grains are linked. It is complex because the market is world wide, the tone of prices being set by Liverpool and because a system of practices has grown up that distorts the working of the economic forces of supply and demand in favour of a chain of middlemen and speculators. In the scope of this short thesis, it is not possible to exhaust the intricacies of the subject or thoroughly to examine the variations in detail over the vast area of wheat cultivation Only a general view of the subject can be attempted.

India produces over an area of 35 million acres roughly one tenth of the world's wheat supply which is marketed through hundreds of *mandis*. Information collected of about 80 *mandis*, big and small of northern India constitutes the basis of this thesis. The accompanying tabular statement contains information of twenty markets selected for their representative character.

Mechanism of the market

In India, except in the Punjab, the grower seldom consumes wheat which has therefore to be purveyed to the richer classes or sent to outside places through middlemen. These middlemen form a chain of which the village moneylender is

* One of the two successful essays which shared equally a prize of Rs. 500 offered by the Imperial Council of Agricultural Research for an essay on wheat marketing.

the first link. He commands the grain of the village in varying proportions, on an average about 25 per cent of it. His price is calculated from the rate prevailing at the nearest *mandi* from which are deducted the *arath* charges, the costs of transport and his own commission varying from 2 to 4 *chattaks* on a rupee worth (1½ per cent to 4 per cent). He also swells his profit by false grading and weighing and misrepresentation of current rates. His position as creditor enables him to command the grain and dictate the price. The greater portion of the grain he receives is sent to the town *mandi* for auction through some *arthi* with whom he has permanent relations and who therefore reduces his *arath* charges. The rest he stocks for sale at better prices or for advancing to growers for seed on a *salsawaya* (25 per cent) or *deorhi* (50 per cent) system.

TABLE I

Name of place	Cultivators (percentage): Selling their grain within two months of harvesting	Compelled to sell to the creditors	Sell to village money-lenders on *kacha hisab*	In cash	Sell to town grocers	Sell to *arthis*	Sell through other agencies	Percentage profit of: Village money-lenders or itinerant buyers	Town grocers	*Arthia* charges: Weighment	*Dane*	*Charity*	*Karda*	False weighment	Excess weight demanded by purchasers	Purchasers profit	Village money-lender's rate of interest	
1	2	3	4a	4b	5	6	7	8a	8b	9a	9b	9c	9d	9e	9f	10		
1. Meerut (Jalalabad) .	66	50	21	20	...	10	...	4½	7	1/9/-	3 ch.	-/1/-	2 ch.	1	½	1	25	
2. Meerut (Hapur) .	75	55	25	10	10	35	20	4	1 sr	1/4/-	-/10/-	-/3/-	-/5/-	1 sr.	-/4/-	1½	...	
3. Allahabad (Kasia) .	75	40	10	30	10	40	50	5	5	-/10/-	-/2/-	1½	4 ch.	2	2	1/9/-	25	
4. Dehra Dun (Chohar-pur) . . .	85	60	25	20	10	26	2	8	7	-/12/6	...	-/1/-	...	5	...	...	25	
5. Agra (Ukhasia) .	70	35	15	30	...	60	50	6½	1 sr.	1/9/-	4 ch.	-/1/-	4 ch.	1	½	2	25	
6. Cawnpore (Sarsaul) .	98	...	20	...	30	...	...	8	1½ sr.	1/9/-	...	4 ch.	4 ch.	...	½	2	25	
7. Benares (Badausi) .	60	40	20	25	20	20	...	3½	7	1/4/-	2 ch.	-/1/-	...	1	...	1/9/-	24	
8. Moradabad (Rajopur)	75	10	5	15	5	30	30	6	6	1/9/-	...	-/1/-	2 ch.	...	...	2	3/2/-	Per month
9. Bareilly (Bandia) .	75	75	25	25	15	15	...	6½	[illegible]	1/9/-	4 ch.	-/1/-	...	5	½	6½	25	

10. Saharanpur (Pathanpura) . .	70	35	30	5	...	35	...	5	4	1/9/-	4 ch.	-/1/-	2 ch.	2½	½ sr.	...	25	
11. Faizabad (Behrampur) . . .	75	...	...	60	20	10	7	1 sr.	1	1	1½	5	...	1½	1½	1½	25	
12. Ghaziabad . .	75	60	25	5	15	35	25	3½	1 sr.	1/9/-	-/10/-	-/1/-	1 sr.	...	½ sr.	1½	...	
13. Gorakhpur (Ramudhia) . .	75	70	10	30	15	...	25	3½	-/12/6	2 ch.	½ sr.	-/-/3	4 ch.	1½	3 ch.	3/2/-	25	
14. Gurgaun . .	75	10	10	10	13	43	...	1½	7	-/5/-	2 ch.	-/-/9	...	...	2 ch.	2	25	
15. Ludhiana . .	70	30	18	20	20	25	...	1½	3½	-/4/-	2 ch.	-/1/-	2 ch.	...	4 ch.	1½	...	
16. Hoshangabad (Babai.)	85	90	5	5	...	...	80	3	1 sr.	2	2 ch.	-/1/-	...	2	...	3	...	
(Bakan) . .	75	50	25	15	10	20	...	4	1 sr.	½ sr.	½	...	...	...	½ sr.	2	25	
17. Hoshangabad (Bamni	75	20	10	5	25	...	30	4	½ sr.	2	-/4/-	...	2	½ sr.	...	...	25	
18. Saugor (Majhera) .	80	60	20	10	20	20	1	5½	1 sr.	1/1/6	-/-/8	-/-/3	-/12/-	½ sr.	2½ sr.	...	25	Per mani of 5 Bengal mds.
19. Saugor (Deori) .	90	30	...	5	10	40	5	5	2 sr.	...	...	...	...	...	...	...	25	
20. Saran . . .	50	40	...	10	...	...	15	5	1½ sr.	-/-/3	-/-/6	-/-/3	½ sr.	2	...	3	25	

Then there are the village grocers and itinerant buyers through whose hands passes probably 15 per cent of the grain. They fall in the same category as the money-lender except that their commissions are lower, lacking as they do, the bargaining powers the latter enjoys as creditor. They moreover do not, as a rule, receive concessions from the *arthi*. They sell outright and depend for their profits (1 per cent to 3 per cent) upon a rapid turnover.

Next comes the town grocer who commands about 15 per cent of the grain mostly from growers who are indebted to him. He buys at nearly all the *mandis* at one seer per rupee less than the prevailing rate (6 per cent to 9 per cent according to the price). Like the village money-lender he has opportunities for manipulating the sales and like him he sells or stocks the grain.*

The grain of about 30 per cent of the growers, most of that purchased by the village money-lender, the village grocer and the town grocer and all purchased by the itinerant buyer is brought to the platform of the *arthi* where in the early morning *pacca arthis* come in numbers and bid for it. When the auction is closed, the seller takes the grain to the purchaser's shops where it is weighed at 40½ seers to the maund instead of the legal 40. There may be false weighing (anywhere from ½ to 2 seers in the maund). Very often there is an excessive deduction for the bag in which the grain is weighed and there is always a deduction of 0-5-0 per cent for dirt. After settling disputes about quality which are raised by the purchaser when the grain is being weighed, the seller is given a receipt to take to the *arthi* on which the final account is made after deduction of 1-9-0 per cent as weighment charges, 0-10-0 per cent as *dane* and 0-1-0 per cent as charity. There can be no doubt that these charges, say Rs. 4-3-0 per cent† are very heavy. The grower pays them because they are of established usage and are extracted from him even when he sells by contract. In some *mandis*, the grain of all the sellers is sold *en masse* thus closing the auction to all but large buyers and thereby reducing competition. Not rarely the *arthis* make purchases for themselves through agents and nearly all of them favour the purchasers with whom they have constant dealings and very often secret agreements for a division of profits.

All middlemen, except the landholder have been enumerated and at this stage their charges can be summarised :

Arthi 2 per cent to 6 per cent.

Town grocer 6 per cent to 9 per cent.

Village money-lender
Village grocer
Itinerant buyer } 1 per cent to 4 per cent in addition to *arthis* charges.

The landholder commands about 10 per cent of the wheat at a price which he himself is likely to receive. The growers get the best price at the *mandi arath* but a

*In some *mandis* where the *arath* system is not in vogue, the town grocer performs the functions of the *arthi* taking as his commission either one seer per rupee or a number of charges akin to *arath* charges.

†These are charges for Ghaziabad but they are a fair index to the general practice.

great many of them are compelled to esll to the moneylender on account of indebtedness or to the village grocer and itinerant buyer for want of conveyance to the *mandi*.

The *pacca arthis* (stockists) who purchase the wheat at the auction may contract to sell it to exporters on a commission basis varying from 0-4-0 per cent to 1-4-0 per cent or they may hold it in reserve for better prices bringing it to the platform according to the prices. The same grain may come as many as ten times to the platform being burdened each time with the auction charges. When the monsoons commence auction transactions cease as the *arthis* lock up the wheat to prevent deterioration and to wait for speculative factors to settle down. In *bhadon* (September-October) when the prices in European markets of which the dependent harvests are garnered, are known and the rains have given a forecast of the *kharif* outturn and the sowings of *rabi*, the *khattis* are opened and wheat is unloaded at a price which remains more or less stable.

Contracts for export of wheat are often made by telegram or letter and much wheat moves overland on account of the difference in prices. Overseas export generally takes place in the harvesting months when it bridges the interval between the antepodean harvests of South America and Australia and those of the northern latitudes.

The element of speculation may now be examined. In many of the larger *mandis* contracts for future delivery recorded on *parchas* and secured by a deposit are made and often registered with the local chamber of commerce. The *parchas* for delivery or acceptance may be purchased by the public but at each transfer the chamber of commerce and the broker who put through the *sauda* receive a commission. The price of these futures and of retail wheat linked to them fluctuates from day to day with the variations in the world market, forecasts, manipulations sometimes, panic very often. Fluctuations however are not considerable and unless due to some real change governing supply and demand are not of long duration but a great deal of money belonging to amateurs is lost to professionals who know what they are playing for. Whether they play for a rise (*taijwallas*) or for a fall (*mandewallas*), they do so on fairly accurate forecasts and unless they are tampering with the market, their operations tend to steady the prices. In addition to these bull and bear transactions, options to buy, sell or to do both can be secured by payment of a premium. If the rise or fall in price makes it profitable, the option is exercised ; if not the premium is lost.

Amateur or dishonest speculation may tend to distort prices for a time but on the whole mistakes or for that matter, dishonesty, counteract their kind and prices remain largely unaffected. The quotations of the Hapur futures for this year, show for instance, that except in the month of April when the price rose by 0-3-0 per maund, probably due to actual conditions of supply, the price in other months did not vary by more than an anna. Much the same is the tone of other

mandis. Speculation therefore does not affect prices anywhere to the extent popularly believed. Nonetheless it is to be condemned on account of the uncertainty it introduces in prices which often stampedes the growers into unfavourable sales.

A very intimate connection exists between the credit of the growers and middlemen and their bargaining power and profits. The grower's credit is the weakest. His old debts due to bad harvests and improvidence have been augmented by the rise in the value of money while the fall in prices of grain has taken away the power of repayment. The growers are generally indebted, which fact narrows the agencies for borrowing, increases the rate of interest and what is far worse, compels the sale of grain at disadvantageous times and terms.

The systems of money-lending are in themselves atrocious. The *salsawaya* system as the term connotes supposedly gives the money-lender a fourth of the advance as interest. In practice he takes far more by the peculiar way of reckoning interest for which the year is divided into three parts, the first from July to October, the second from November to March and the third from March to July. Interest is reckoned at 25 per cent and 12½ per cent on all advances made during the first and second period respectively without reference to the month. No interest is charged for advances in the third period. Actually the loans of the cultivator are naturally so distributed that the *salsawaya* is calculated to work up to 45 per cent per annum, while the *deorhi*, not unknown works up to double that rate.

There are other agencies for borrowing, the Kabuli, for one, whose rates are higher and whose harshness in collection is unmitigated. Co-operative banks finance cultivators at interests varying from 10 per cent to 15 per cent but as prepayment of loans is a precedent condition, the grower rarely avails himself of this agency.

The village money-lender does business on his own capital and when tempted into larger investments obtains loans from *mandi* money-lenders at rates varying from 9 per cent to 12 per cent. His operations generally are limited by the small capital and the relatively high rate of interest he pays and for this reason he unloads the grain instead of holding it for better prices as the *mandi* money-lenders and *arthis* do.

In respect of capital, the village grocer is practically in the same category as the money-lender. The itinerent buyer has no reserves to speak of and works often on money borrowed at interest from 12 per cent to 18 per cent. The auction *arthis* generally obtain money from deposits, joint stock banks, exporting firms and shroffs at interest varying from 9 per cent to 11 per cent. The stockists and in smaller *mandis* auction *arthis* who stock grain in *khattis or kothas* obtain accommodation to 75 per cent of the value of their stocks from joint stock banks at a rate of 7 per cent. This relatively cheap money enables this class of middlemen to stock grain for better prices or speculation.

Operations in the wheat market are in essentials remarkably uniform over the area of production in *mandis* big and small. As the abstract shows, variations are only in detail of the relative importance of different middlemen. It remains to be added that in addition to upcountry *mandis* wheat is stored in large quantities at the ports, Karachi, Bombay and Calcutta. Karachi enjoys importance because on account of its low rainfall, its storage facilities are better and on account of its position it commands the wheat of the Punjab and Sindh which are the chief exporting areas.

WHAT DETERMINES WHEAT PRICES

As has been shown, the prices obtained by the grower follow the *mandi* rate from which definite deductions are made according to the middleman to whom the fates may deliver him. The *mandi* rate is not fortuitous or dependent to any appreciable extent on the bidding of the *arthis*, though outwardly it may appear so. Overruling the fastnesses of all the middlemen and *mandis*, the economic forces of supply and demand determine the rate in each market, a market being an area in which at a given time, the price of all commodities of the same description is the same. Differences in price due to freight or other charges, define a market but a rise in price may overcome the difference and merge two or more markets together.

In a market, the economics of price are that any given time, the marginal demand or utility determines the price for the existing supply. Over a longer period of time, demand being constant the costs of production of the marginal producer determine the price. In applying these laws to wheat, it is to be remembered that wheat because it can be stored, graded, transported and is in universal demand, is a commodity of international value. The market for it tends to expand or to contract according to the prices.

The following facts about the wheat market may therefore be inferred——

1. Wheat is a mobile commodity, its markets being determined in these days of transport facilities and alert business organisation, by prevailing prices.

2. The highest price prevailing in any component market determines the prices in all other markets.

3. Transport charges represent the bulk in the difference in prices at different places.

4. As storage facilities are deficient in India, the marginal utility of the entire available supply determines the price. The larger the market, the more difficult it is to regulate supply which therefore is a passive factor in determining prices.

5. The total supply in the world market is extremely fortuitous for many reasons, chiefly (*a*) wheat is harvested in different months in different parts of the

world which makes forecasts difficult, (*b*) consumption is not stable as wheat substitutes and is substituted by other cereals as an article of food, according to the prices, (*c*) absence of alternatives in the shape of crops or employment may compel production below costs of production, (*d*) changes in tariffs and currencies and specially the recent militant nationalism of several countries to be self-sufficient upsets attempts to equate supply to demand at a determined price.

6. Wheat prices fluctuate markedly between seasons as the majority of cultivators bring the grain to market at harvest time, which lowers marginal utility.

7. India with a wheat acreage of 35 millions can produce all the grain required for internal consumption and at least in years of good crops there is a surplus. This surplus can be exported only if foreign prices rise by at least the cost of transport which *ex*-Karachi to Liverpool is about Re. 1 per maund.

8. The production of wheat is becoming subject to the law of diminishing returns as is evident from the following figures :—

	Area (million acres)	Outturn (million tons)
1901-02	18·63	6·09
1930-31	32·18	9·30
1933-34	35·7	9·36

Do the prices constitute a fair return to the grower

This really involves two questions (1) whether the prevailing wheat prices are fair and (2) whether the grower receives a fair proportion of them. The fairness of prices depends firstly on their relation to the costs of production. The present price of wheat upcountry, near the source of production is, on an average, Rs. 2-8-0 to Rs. 2-12-0 a maund, while at harvest time it was six to eight annas less. In places further away, the price may be higher but the difference almost wholly represents the cost of carriage and is not part of the real price. In regard to cost of production, attached is an estimate prepared for me by the Superintendent, Government Agricultural Farm, Meerut, which I have checked from data I have myself collected The price of the Government Farm product is Rs. 2-1-9 or Rs. 2-3-9 per maund according as the field is irrigated from canals or from wells; while the costs for the cultivator are Rs. 2-8-0, Rs. 2-12-0, Rs. 2-4-0 according as the field is irrigated by canal or well or is unirrigated. These costs, if anything, are underestimated because they assume, even for unirrigated fields, an outturn of 882 lbs. while the average outturn for India this year is 589 lbs. To these costs must be added marketing charges varying from 2 per cent to 10 per cent and transport charge

4 to 5 pies on *kachcha* roads and 2 to 3 pies on *pacca* roads. The production costs therefore are in excess of the prices even in an area like Meerut where the yield is relatively high for India.

TABLE II

— —	Cost per acre at Government Farm taking an average of 30 mds. (2,400 lbs.) per acre	If irrigated from well	A cultivator's irrigated area taking an average outturn of 15 mds. (1,230 lbs.) per acre	If irrigated from well	A cultivator's irrigated area taking an average outturn of 10 mds. (882 lbs.) per acre
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Rent . . .	20 0 0	..	10 0 0	..	8 0 0
Canal dues . .	3 12 0	7 8 0	3 12 0	7 8 0	..
Ploughing and levelling . . .	15 0 0	..	8 0 0	..	6 0 0
Manuring . .	10 0 0	..	5 0 0	..	..
Seed and sowing .	4 8 0	..	4 0 0	..	4 0 0
Watering . .	1 2 0	..	0 12 0	..	..
Roguing and weeding, etc. . . .	0 8 0	..	..	..	..
Harvesting . .	2 8 0	..	2 8 0	..	2 0 0
Threshing and winnowing . .	6 0 0	..	3 8 0	..	2 8 0
Total cost .	63 6 0	67 2 0	37 8 0	41 4 0	22 8 0
Cost per md. of wheat	2 1 9	2 3 9	2 8 0	2 12 0	2 4 0

This estimate does not allow for depreciation on live stock and implements but this may be set off against by products like *bhusa*.

The question then arises why and how wheat is grown on these terms. The answer is that wheat must be grown in *rabi* if only to pay the rent and to find employment. The grower continues to produce wheat because (1) he confuses his wages with profits, (2) some cultivators pay lower rents on privileged holdings, (3)

they all are content to pile arrears in the hope of better times when they can clear them. It must also be remembered, first, that these costs of production are for the average holding but there are a great many holdings the fertility of which is below the average and the rent of which is above the same. Secondly, these costs are for the average year but in bad years, the outturn may be much less.

During the last four years, the economic friction occasioned by the fall in prices works against the grower, whose costs of production especially rents, debts, canal dues, litigation expenses and railway freights have not fallen in the same proportion as the price of wheat. Index numbers, left out for lack of space, reveal the disparity in the fall in prices of wheat and the general fall in prices.

Costs of production vary for different growers or classes of growers but as this is due to natural causes, it is sufficient to be brief. The distance of the village from the *mandi* or place of consumption, the condition of the holding in respect of soil and water, variations of rent due to individual landholders or class of tenure, the condition of local supply in respect of demand, the extent to which labour is provided by the grower or his family are some of these natural factors. They result in giving a larger or smaller share of the prevailing price to the grower.

The question requires to be investigated as to why wheat prices, protected by a tariff wall of Rs. 1-7-0 per maund, in a year of low outturn should be so near the cost of production. I incline to the view that there is overproduction. The Crop Planing Conference considered, on the contrary, that this year's outturn of 9·38 million tons meets more or less the estimated internal consumption of 9·5 million tons and that if the yield per acre be better, this would provide a margin for the area contracting for want of rain. In this connection the following facts require to be considered :—(1) the outturn this year does not represent the normal. The yield per acre for the United Provinces and the Punjab which between them account for three-fourths of the supply, was in the quinquennium 1921-22 to 1926-27 ordinary years, 1,050 lbs. and 795 lbs. respectively. For the whole of India, it is difficult to find many years, the outturn of which compares with the present one. (2) Contractions in area due to rain are not considerable as is evident from the figures for the United Provinces; the province probably most dependent upon rains for sowing the area variations of which from 1921 to 1929 have been 99, 102, 104, 107, 100, 97, 108, 103. (4) The demand for internal consumption is efficient at 9·5 million tons* only on account of the low price. Any rise in the price, a consumption devoutly to be wished, would reduce this demand. (5) Export which in pre-war years averaged 1·3 million tons has completely ceased of late and was last year actually exceeded by the import. (6) The stocks of last year estimated at 2·2 million tons increase the available supply. (7) Wheat acreage has increased by nearly 40 per cent since 1901 which is the highest increase for food grains. The Sakkur barrage will in time add another 2 million acres in Sindh. Even a very slight increase in the outturn of this vast acreage must cause an excess of supply

* Sir Frank Noyce estimated the internal consumption at 8·5 mill.

for which at prevailing prices, there is no outlet. The result of a surplus of wheat in the country is twofold—(1) psychological which in itself would have a depressing tendency, (2) a depression of prices at least *pro tanto* by the cost of carrying over a surplus which includes deterioration and storage charges and interest on capital.

The next question to be considered is whether the grower obtains a fair proportion of the price. The various deductions which the price of the grower suffers, are —

(1) Marketing expenses varying from 2 per cent to 10 per cent according to the middleman are too high absolutely for the service rendered and comparatively with other countries.

(2) As many as 90 per cent of the growers in Hoshangabad district and on an average about 40 per cent of all growers are compelled to sell to creditors at unfavourable rates.

(3) Over 70 per cent of the cultivators are compelled to sell wheat within two months of threshing it on account of debts, rents and lack of storage facilities. The difference in price between the harvest and other months can be ascertained from the Crop and Season reports of the various provinces. For the United Provinces, Table III shows how wide is the arc of oscillation between the prices in May and November. Details for other provinces which have to be omitted for lack of space reveal the same variations in prices. Only a small part of the difference can represent the storage and interest charges while the rest is the price of the grower's helplessness.

TABLE III

—	Number of seers per rupee	
	May	October
1924	8·50	7·0
1925	6·75	6·62
1926	6·75	6·75
1929	7·75	7·0
1930	11·0	13·50
1931	17·0	14·0
1932	13·80	10·0

(4) Bad roads make transport charges heavy and being unusable in the rains compel the cultivator to sell at the season of lowest prices. Railway freights not reduced since 1911 are now rendered disproportionate by the fall in prices.

Crop and Season reports for U. P.

The figures for 1928 and 1929 could not be furnished as one book of the series was not available.

(5) Municipal taxes, unless the wheat is for local consumption when they are returned in the price, are paid by the grower.

(6) Speculation, by the uncertainty it introduces in the prices, deters the grower from stocking his grain for better prices.

THE STEPS NEEDED TO ENSURE A FAIR RETURN TO THE GROWER

Marketing practices present the first tangible problem in wheat prices and doubtless regulated markets would save to the grower a fair portion of the price now lost by false weighments and extortionate dues. The Royal Commission on Agriculture recommended that the regulations of the Bombay and Berar markets with some modifications, notably adequate representation of the growers, should be extended by legislation all over India. These regulations for 'the levy collection and disposal of fees, the conditions under which licenses may be issued to brokers, weighmen and measurers, the places of weighment and measuring, the scales, weights and measures to be used, their inspection, verification and correction' must secure a larger portion of the price to the grower and may by a simplification of the obtaining devious methods, introduce healthy competition and raise prices. The less mystification there is about marketing, the more active will be the part of supply in determining prices. The grower will be enabled, with more assurance to extend or curtail his cultivation or to stock or sell his wheat. The Royal Commission also envisaged that regulated markets would provide storage facilities, correct information about rates and marketing conditions, agricultural propaganda and banking facilities.

Even regulated markets will not eliminate the middleman whose services are indispensible for a commodity like wheat. But if he cannot be eliminated, he can be opposed by rivals whose competition should reduce the charges. Of these rivals, Co-operative Sale Societies, which have been tried extensively in the Punjab for wheat and with the experiment of which the author has been associated as chairman and director of three banks, secure for the cultivator a price from 10 per cent to 30 per cent better than what he would obtain in the open market. In the experiments with which the author has been associated, the co-operative bank bought the grain outright from the cultivator at prevailing prices without any commission and sold the same in the season of higher prices. After allowing for storage, deterioration and interest charges, the bank was able to make a profit which was divided between itself and the contributing growers. Not only this but the presence of the sale society tended to raise the general prices and to reduce the commission charged by the *arthis*. There are several variations of the methods of buying but the method followed by the author which is a modification of the German system seems to induce more confidence than other methods which leave the growers with a larger share of the risk.

Something might be done in the way of reducing transport charges which appreciably swell the grower's costs. The difference in costs on *pacca* and *kachcha* roads is more than 2 pies per maund per mile. Extension therefore of metalled roads and

improvements in *kachcha* must reduce costs to the grower. In respect of railway freights, even if a general reduction be deemed impossible, a special reduction should be made on consignments to ports which will enable shipments abroad and will keep out foreign imports. Also judicious concessions may open up new markets where at present prices are rendered prohibitive on account of freight.

Indebtedness, as already emphasised, is an important factor in wheat prices. The Royal Commission wrote 'The full benefits of improvements in market organisation cannot reach the mass of cultivators unless their financial position is such that they can act as free agents and market their produce where they please.' Since the time of the Commission, the fall in prices has augmented old debts and occasioned fresh borrowings on all of which the lowest rate of interest the cultivator pays is 25 per cent. No cultivator can pay this interest and hope to be anything but an economic slave. Co-operative credit may help but it will be first necessary to free the cultivator from the existing burden and to teach him better methods of agriculture and wiser ways of spending.

An improvement in prices may result if speculation in wheat is restricted to genuine wheat dealers. Amateur speculation is wasteful and disturbs prices by allowing opportunities for manipulations and tampering with the markets. If this were prohibited and speculation restricted to genuine dealers, expert knowledge and competition of an intelligent order would be brought on the problem which would probably stabilise prices.

The question of fixing a minimum price for wheat deserves careful consideration. The United Provinces Government is fixing a minimum price for sugarcane, a far simpler problem, the consumers being factories which can be subjected to regulation. Also the economics of price regulation in respect of a commodity like wheat are less clear and more complex. Attempts to disturb the working of the natural forces of supply and demand, to be successful should have no defects which is too much to expect in regard to wheat with its scattered production over a vast area and under varying conditions. Though the general public could be justly asked and would probably without much grumbling pay more for wheat, price fixation may not be easy to achieve and may cause overproduction or contrariwise restrict the market wheat is acquiring by substitution of other cereals.

Currency and exchange are important factors in prices but it is not possible to deal with them in detail. A general inflationist policy may remove the economic friction working against the producers of raw materials in favour of persons with fixed incomes. The American experiment has its lessons for us. In respect of exchange, the 18 pence ratio, not without advantages to a debtor country like India, makes Indian wheat dear in foreign markets. The Ottawa preferences fortunately serve to offset this tendency so far as the United Kingdom, the chief importer, is concerned.

In regard to export to foreign countries, little can be done. Better farming of better soils in competing countries and cheaper freights by land and sea shut Indian

wheat out of many markets, unless some seasonal scarcity or widespread war raises the prices very much above the prevailing level. Regulation of production by a system of quotas may improve and stabilise prices. Unfortunately India is not in a good bargaining position to benefit by this and it is too much to expect that any concessions will be made to her when she has not contributed to the world market for the last four years in any appreciable quantity and her costs of production are so high.

Internally, the problem of overproduction which threatens to intensify can be met by a careful study of costs of production in different areas and a programme of crop planing in the light of the results. Other cereals, condiments, oilseeds, fibres, fruits and vegetables must under careful guidance substitute wheat over areas which may be subject to diminishing returns. Any marketing scheme for wheat must therefore be accompanied by a carefully considered agricultural programme.

The problem of wheat prices, as noted in the beginning, is bothvast and complex. It is not entirely a marketing or a local problem ; it has its roots in the fundamental economics of production in this country and to certain extent all over the world. A careful and comprehensive study is necessary and the problem must be attacked from various directions in carefully regulated instalments.

WHEAT PRICES IN INDIA*

BY

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CONTENTS

PART I.—THE EXISTING MECHANISM, METHODS AND VARIOUS FACTORS WHICH DETERMINE WHEAT PRICES IN THE PRINCIPAL INDIAN *MANDIS*

PART I.—THE EXISTING MECHANISM, METHODS AND VARIOUS FACTORS WHICH DETERMINE WHEAT PRICES IN THE PRINCIPAL INDIAN *MANDIS*

1. DEFINITION OF A *MANDI* AND SCOPE OF THE THESIS

The term *mandi* as defined by Royal Commission on Agriculture is " a set of shops built round three or four sides of a rectangle, a wide brick pavement being

*One of the two successful essays which shared equally a prize of Rs. 500 offered by the Imperial Council of Agricultural Research for an essay on wheat marketing.

provided for unloading, examining, cleaning, weighing, and bagging the grain". But it does not mean that in very important wheat centres like Hapur and Amritsar where there are such rectangluar *mandis*, the large portion of the work carried on in the scattered shops of *artias* in the vicinity, is to be ignored. These *mandis* at the same time are not exclusively meant for wheat transactions but other commodities like cotton, grams, maize, etc., are also dealt with.

2. Distribution of wheat area sown by provinces

The most important wheat centres comprise three provinces, namely, the Punjab, the United Provinces and the Central Provinces. The following table of distribution of areas grown will clear the fact :—

	1933-34	1932-33
Total area sown	36,062,000	32,970,000 acres

Has increased by 9 per cent.

TABLE I

Area sown by provinces

Provinces	Area sown in 1933-34 (acres)
Punjab	11,292,000
United Provinces	8,580,000
Central Provinces and Berar	8,580,000
Bombay	3,826,000
Bihar and Orissa	1,222,000
North-West Frontier Province	1,041,000
Bengal	145,000
Delhi	46,000
Ajmer-Merwara	29,000
Indian States	4,258,000

3. Total yield

	1933-34	1932-33
Total yield	9,358,000	9,449,000 tons

This has decreased by 1 per cent.

TABLE II

Yield of provinces

Provinces	Yield 1933-34 (tons)
Punjab	3,253,000
United Provinces	2,512,000
Central Provinces and Berar	735,000
Bombay	790,000
Bihar and Orissa	476,000
North-West Frontier Province	241,000
Bengal	41,000
Delhi	18,000
Ajmer-Merwara	7,000
Indian States	1,225,000

This shows that $\frac{2}{3}$ of the total area sown in India belongs to the Punjab and the United Provinces, and $\frac{3}{4}$ of the total yield is shared by these two provinces. A large number of important wheat *mandis* naturally exist in these two provinces. Again the number of *mandis* is more in those districts which produce more wheat. For instance in the Punjab Canal Colony, Lyallpur district alone has 7 *mandis* and all of these are of equal importance.

4. SITUATION OF *MANDIS*

Most of these *mandis* are situated quite near the railway goods sheds except Hapur which is about $\frac{3}{4}$ of a mile away. The difference in distance of these *mandis* vary but the important regions have a distance of 12 to 50 miles from each other. The average distance from which a cultivator comes to the *mandi* is 10 to 12 miles.

The cultivator at the border line will consider the distance, the rate of prices, and the condition of roads and bridges before he goes to any *mandi*. For instance the cultivators of "Khidder ke Jalal" village cannot take their stock to Tandlianwala which is much more nearer to them, due to no bridge over a stream in the way and have to go to Lyallpur.

5. Transportation and communication

Cultivators have to face tremendous difficulties in transporting their stock to the *mandis*. Firstly, the condition of roads everywhere is unsatisfactory. The condition of main roads which connect the district with the tehsils is in fair order, but the adjoining roads which connect the main road with villages are great setbacks to the cultivators.

To this is added the immensed trouble and anxiety caused by the inefficient and weak bullocks.

6. Means and rates of transportation

Sellers (cultivators and village *baparis*) use different means for conveying their wheat—like bullock-carts, donkeys, camels, and mules. Ninety-five per cent of the sellers bring their stock by carts. In the Punjab 'Abadkars' or immigrants use carts and the *jangalis* or ancient residents use donkeys and camels. At Amritsar nearly 50 per cent of the sellers use carts and 50 per cent use donkeys. Whereas at Hapur use of carts is 75 per cent and that of donkeys about 25 per cent.

These carts belong to the cultivators themselves in most of the cases but some of them have to hire. The rates of hiring depend upon the distance and weather conditions, but usually the rates are stationary and fluctuate very rarely. For instance the following are the average rates of bullock-carts.

	Rs. A. P.
For 5 miles	0 0 9 per maund
From 5 to 10 miles	0 1 0 to 0 1 3 per maund
" 10 " 20 "	0 1 3 to 0 2 0 "
Above 20 miles	0 2 0 to 0 3 0 "

7. The internal conditions of *mandis*

Not only have the cultivators to surmount these obstacles in the way, but also they have to face many other handicaps. Having reached the *mandi* the cultivator unloads his wheat on the pavement in front of his *artias'* shops. But after this the cultivator has no place where he can retire and take rest. There are no sheds to shelter the cattle from the scorching heat of the sun. Lack of water supply adds fuel to the fire. They have to rest their cattle under the shade of trees outside the *mandi*, but at some *mandi* like Okara even trees are not to be seen all around. These conditions prevail almost in all the *mandis*. When rain falls their condition becomes worst. The wheat lying in uncovered heaps is utterly spoiled. Some flourishing shops keep *tarpals* to cover it but others have no alternative but to let the stock waste away. The prices fixed of such wheat is at remarkably low rates. Since the wheat season lasts till August, difficulties due to rain are quite

frequent. The result of all these defects is that cultivators are anxious to get away from these *mandis* as early as possible.

8. Season and daily times for wheat transaction

The season lasts from April to August. The daily times for wheat transactions vary slightly in different *mandis*.

Table III

The daily working time in important Indian wheat mandis

Name of *mandi*	Daily time	Time of wheat transaction
Lyallpur	9-30 A.M. to 5-30 P.M.	10 A.M. to 2 P.M.
Gojra	10 „ „ 6 „	11 „ „ 1 P.M.
Jaranwala	10 „ „ 6 „	*5 to 6 P.M.
Toba Tek Singh . . .	10 „ „ 6 „	*6 P.M.
Okara	9 „ „ 6 „	9 A.M. to 6 P.M.
Batala	10 „ „ 6 „	9 „ „ 2 P.M.
Ferozepore City . . .	6 „ „ 6 „	
Ambala City . . .	6 „ „ 6 „	6 A.M. to 2 P.M.
Amritsar	8 „ „ 4 „	9 A.M.
Hapur	8 „ „ 9 „	8 A.M. to 2 P.M.
Karachi . . .	10 „ „ 7 „	

* They keep in touch with speculation rates and then fix the price.

9. The number of cultivators who come to *mandis*

The various difficulties in conveying wheat to *mandis* and expenses in the form of cartage, live-stock, on himself and wastage of time, lead some growers to dispose of their wheat to the village *banias* as well as to retail purchasers. Sometimes the grower has taken advance money by mortgaging the harvest.

TABLE IV

The average number of the growers, and baparis (banias) *coming to* mandis

Name of *mandi*	Percentage of growers	Percentage of *baparis*
Lyallpur	50	50
Okara	60 to 70	35
Gojra	60	40
Toba Tek Singh	50	50
Batala	20	70
Kotkapura	90	10
Ferozepore	75	25
Amritsar	25	75
Hapur	60	40

When making a purchase the *baparis* deduct cartage and some margin of profit. Often the *baparis* weigh the weight themselves and thus get about 10 seers more wheat for each bag. These *banias* who are financially better off store the stock and wait for better rates. Thus lack of resources debars the grower from the benefit which would have accrued to him but is taken away by this additional and unnecessary intermediary.

10. REASONS FOR THE IMMEDIATE SALE OF WHEAT BY THE GROWERS

The reasons why growers cannot wait and want its early disposal are of course inbred in their poverty, illiteracy and lack of resources. The following are their immediate needs with approximate percentage :—

1. Lack of adequate store-houses in the village	..	
2. Payment of land revenue	51	per cent
3. Payment of debt	30	,,
4. Maintenance of live-stock	2·5	,,
5. Purchase of seed, plough and other implements	1·5	,,
6. Marriage of their children	8	,,
7. Land rent	6	,,

For these needs they sell away their wheat during the season when rates are low on account of new arrivals. Some cultivators, however, store their wheat with their *artias* when the rates are very low till some better time. For this they pay

rent and interest on advance. This is all the more bad because they often pay more in one form than they get in another. This year it has been noticed that the growers are keen on selling and have nothing not even ornaments to take advance. This is observed from the fact that stock of wheat at present is more in every *mandi* than last year. At Lyallpur it is 3½ lakh of bags as compared to 2 lakh of the last year. Those who can wait are exceptionally rich and well-to-do *zemindars* who have enough income otherwise to keep their expenses. Their number is certainly not more than 5 per cent.

11. The different qualities of wheat

The important qualities are 'sharbati', 'white' and 'dara'. The 'sharbati' is the best of the lot and its rate is usually 0-1-0 to 0-2-0 higher than that of 'dara'.

12. Methods of sale

Having unloaded the wheat into various heaps of not more than 50 maunds each, one of the following methods of sale is followed :—

(1) Under cover system—
 (*a*) Single bid system
 (*b*) Repeated bids system
(2) Auction
(3) Open-bid
(4) Other special method

TABLE V

The system of sale used in different mandis

Mandis	System of sale	
Lyallpur	Under-cover	Single bid
Jaranwala	,,	Repeated bid
Gojra	,,	Single bid
Toba Tek Singh	,,	,,
Sangla	,,	Repeated bid
Sargoda	,,	Single bid
Ambala City	,,	Repeated bid
Okara	,,	,,
Rohtak	Open bid	
Batala	Under-cover	
Kotkapura	Auction	
Ferozepore City	Under-cover	
Amritsar	,,	Single bid
Karachi	Through brokers	
Hapur	Open bid	

(1) In under-cover system, the party of *dalals* move only for single round starting each day with the next shop in turn. Each *dalal* tests the wheat by putting his hand deep into the heap and informing his offer to the *artia* under the covering of a piece of cloth by the movements of fingers. The price is expressed in terms of rupees, four annas, annas, pice and half-pice. For each part of price specific number of fingers are represented. The process is carried on under cover and is meant to keep other bidders in dark, still other cleverly keep vigilance and at once understand the bids of others. The highest bidder in this way settles the bargain.

The difference between single bid and repeated bid is that under the former *dalals* can offer his rate only once ; whereas under repeated bid he can raise it again. This is permissible because the bids are known only to the *artia*. *Dalal* can also decrease his offer if he happens to find some defect which he could not see before. But the convention always stands to encourage single and highest bid because it saves time.

Binding power.—The purchasers can refuse the bargain on the plea that heap as deep and they could not see the quality underneath it or some such excuse There are different systems in various *mandis*—

1. Buyers and sellers are at liberty to break off the bargain at any time and for any reason, as in Rohtak. This leads to inconvenience and uncertainty of bargains. But privilege is enjoyed by both.
2. *Kachcha* for buyer and *pacca* for seller. Buyer alone can refuse the bargain. This again gives uncertainty to the seller.
3. Bargains are *pacca*, but buyers can claim the recompense for bad quality and this affords enough opportunity for troubling the sellers. The growers are usually exploited.
4. *Pacca* for seller and buyer both if heap is less than 50 maunds. If more than that the penalty can be imposed or bargain can be cancelled in certain cases.

When such difficulties arise, usually the seller accepts the lower rates otherwise he has to bear unnecessary expenses like weighing, labouring and cartage.

Merits—

1. It saves time because, every *dalal* gives his highest bid so that he may not loose the opportunity of purchasing.
2. Cover system leads to smooth working and there are less chances of hue and cry in the *mandi*.
3. *Artia* cannot corrupt the system by handing over the stock to his friend who has given a lesser bid because others being aware of their offers will protest.
4. There is a reasonable amount of competition even under this system. If the *dalal's* offer under certain rate is rejected at one shop he will certainly raise his offer at the next otherwise he will not be able to purchase at all.

Demerits—

1. Cultivators remain in total darkness and thus take no interest. *Artia* can speak a lower rate to cultivator than what actually has been settled as they do not come in contact with *dalal*.
2. *Artia* can communicate to his friends under cover the latest highest bid and thus the latter finds opportunity to increase his offer.
3. Heaps are sold in *dara* (Please see under *dara* sale).
4. *Artia* can refuse even the highest bid and may keep the stock for himself He satisfies the cultivators with the prevalent rates.
5. Sellers are discouraged to take keen interest in the transaction and all depends on discretion and disposition of the *artia*. Procedure adopted is too complex for the cultivators to grasp.

(2) Auction is held for every heap separately. It is practised at less important *mandis*. It is done in usual manner by inspecting the grains of every heap.

Merits—

1. Since the auction is open and straightforward sellers are in a position to keep in touch, observe and realise what is going on. Thus there will be less chances of their being robbed.
2. Under auction competition is likely to be more keen and intense.
3. Cultivators like auction and take interest which otherwise they completely ignore and leave to the circumstances, the whim and honesty of *artias*.
4. Auction can eliminate buyer's *dalals* since they can judge from the offer of other buyers. But *dalals* in big *mandis* are desirable.
5. Different heaps are disposed of separately and thus cultivators who bring better quality will get their due.

Demerits—

1. It takes more time and becomes unmanageable to clear the stock in a big *mandi* unless some system of grading the produce is developed.
2. Experienced merchants are unable to derive any advantage of their experience and are at the same footing along with unexperienced.
3. If real buyers are few in auction, prices may tend to be lower.
4. There is likelihood of the *artias* closing the auction at a lower price offered by his friend.

(3) Under the open bid system rates are fixed openly but unlike auction where the *artia* repeats the latest offer and exhorts the buyers to bid higher. The bargain is exactly done in the manner of ordinary shop transactions. This system is prevalent at Hapur (U. P.) and Rohtak.

Merits—

1. If *artias* are honest and well wisher of the cultivators they can secure a better price for the produce.
2. By mutual decision and unity *artias* can fix a minimum rate.

Demerits—

1. The system is effete and competition is less intense and active.
2. The margin of *artias*' discretion widens. If he joins with the buyers he can sell the wheat at a lower rate. *Artia* also robs by giving the cultivator a lesser rate and at the same time charging high rate from the buyers.

(4) Some flourishing concerns invite the *baparis* and declare their conditions to them, samples alone are shown and each *bapari* offers his highest bid by writing it on chits. Thereupon either the highest offer is accepted or rejected. Examples, of such concerns are :—

1. Zemindars Co-operative Society, Ltd.
2. Producers Trading Co. both at Okara (Punjab).

The obvious advantages are that only samples decide the bargain and the stock is not dealt with. Unnecessary conveyance weighing and labour expenses are avoided. At the same time it is another way of disposing of the stock if it is not cleared by an ordinary method.

'*Dara sale*'—

This is common in almost all the *mandis*. The heaps of different qualities are sold at the flat rates, and no separate price is fixed for the superior stuff. It is up to the *artia* to determine the quality of wheat. Most of the heaps he labels as inferior and thus deducts much from the fixed rate. This usually discourages the cultivators who knowing that they cannot get better price rarely produce better stuff. In addition to these advantages, "dara" system saves considerable time of both the *artias* and the *dalals* and it also saves their necessary accounts for separate heaps.

13. The intermediaries

The need for intermediaries who should represent and act on behalf of the sellers and buyers have been universally recognised.

(*a*) *Artia*—

The *artia* is a commission agent on behalf of the sellers and bargains with buyers' *dalals*. He is really a pivot in a *mandi* on whom the whole business rotates. His presence is a matter of necessity and there can be no regular *mandi* without an *artia*. Originally he is meant for the prosperity and fair return of the cultivators but he often indulges in dishonest methods and tries his level best to rob his clients.

The following are some of his important functions :—

1. To sell the wheat of the cultivators or village *bamparis* at the highest possible rates. For that end, he receives various offers from the buyers either through cover system auction, or open bid.
2. To arrange for weighman and to get the wheat correctly weighed.
3. To effect the payments of cultivators who are usually paid in cash immediately the weighing is over. The *artia* receives the bill from the buyer later on.
4. To arrange all kinds of labour needed for the delivery of the goods.
5. He gives advance to the cultivators. But in these days it is very rarely done due to risk involved in the unreliable conditions of the cultivators and government legislations. But about the harvesting time it is lended at an exhorbitant rate.
6. He is also supposed to look to the convenience of his clients, but it is hardly done. The shrewd *artias* some time display this in order to attract them.

(The fee charged by *artia* is shown in Appendix V—A.)

Three kinds of artias—

1. *Kachcha artia.* He is wholeheartedly an agent of the seller and deals only with the sale of his wheat at the best possible rates. He does not deal with speculations.
2. '*Pacca artia.*' He is a medium through whom buyers purchase in a *mandi.* His chief function is to buy the desired quality of wheat within the rates instructed by his clients who may be an owner of mill, European firms, stock-holders or retail purchasers both locally and of outstation. *Pacca-artia* is a man of position, wealth and prestige in a *mandi.* Some of his other duties are that he pays cash payment to *kachcha artia* from whom he buys, before he receives from his buyer. He arranges for weighing, labouring, bagging, and despatching for the wheat. Above all he speculates about future rates.
3. *Kachcha pacca artia.* He is an agent of both sellers and buyers or in other words he sells as well as buys. He really plays a mysterious part because he receives the cultivators and at the same time receives orders from the buyers. He does this by his personal bid. He may either jot down his offer on paper and put it down into the heap, or tells his bid to a third man, or transfers his role to another man and himself becomes competing *dalal.*

Kachcha pacca artia occupies a very lucrative job.

1. He gets double commission from both the seller and the buyer and thus is at an immense advantage.
2. If the round of moving *dalal* is over, he is all in all in determining the rates of the day and practically dictates the seller and the buyer.

3. He often tells a lower rate to the seller and higher rate to the buyer and thus makes deductions from both the sides.
   Similarly he deducts from all the items accordingly.
4. The *Kachcha pacca artia* can show favour to the seller or to the buyer whomsoever he likes.
5. As he receives orders from outsiders he is at liberty to provide them even out of previous bargain. He can get him from other *artias'* shop or his own as it benefits him.
6. He is also a speculator.
7. He can refuse the highest bid and can keep the stock for himself and settles with the cultivators on minimum possible rates.

These corruptive and one-sided methods speak enthusiastically for some immediate checks. Much of these can be removed if sellers present themselves and take interest in the mechanism.

TABLE VI

Number of artias' *shops at important Indian wheat* mandis

Name of *mandi*	*Kachcha artia*	*Pacca artia*	*Kachcha pacca artia*	Total
Lyallpur	38	16	45	99
Gojra	50	30	10	90
Jaranwala	56	7	7	70
Toba Tek Singh	55	8	7	70
Okara	50	25	23	98
Ambala City	75	4	20	80
Batala	30	4	..	34
Abohar	61	13	20	94
Rohtak	..	..	57	57
Kotkapura	80	20	..	100
Ferozepur City	35	15	..	50
Tandlianwala	75	..	..	75
Amritsar	44	200	..	244
Hapur	90	50	100	240
Karachi	..	over 100	..	..

(*b*) *Dalals*—

Dalal (broker) is an agent of a buyer. He need not keep a shop nor invests any capital. His presence is not essential like that of *artia* but almost all the *mandis* have such *dalals*.

His chief functions are the following :—

1. To purchase wheat for the purchasers at the lowest possible rates.
2. He offers the rates to *artia* either through the cover system or openly as the case may be.
3. His daily business is to get orders from *pacca artia*. He is responsible for the smooth handling of the bargain till the end.
4. He is responsible for the bargain and the delivery but not for the payment.
5. He is responsible for judging the quality, weight, moisture contents and variety.
6. He reports in the evening the daily wheat arrival in the *mandi* and the rates fixed.
7. *Satta dalals* keep themselves in close touch with the fluctuations of rate at important wheat markets, and are always on the look out for making a bargain between a buyer and a seller.

TABLE VII

Shows the number of dalals *and the rates of their charge at the various wheat* mandis

Name of *mandi*	Total No. of *dalals*	Rate of commission			Rate of commission in *satta* transaction			
		Rs.	A.	P.	Rs.	A.	P.	
Lyallpur	120	0	1	3	0	1	0	per hundred rupees
Gojra	100	0	2	6	0	2	6	Do.
Okara	90	0	2	0	0	2	0	Do.
Kotkapura	30	0	2	0	0	2	0	Do.
Amritsar	1,500	0	5	0	0	8	0	Do.
Hapur	350	0	2	0	0	2	0	per *satta*
Karachi	500 only 200 active							

14. Determination of prices

The price of wheat is governed by the same general principle which governs every other commodity—namely, the principle of supply and demand. If the demand for wheat—foreign or internal—increases, the rates will go up and more so if with increased demand the supply decreases, and *vice versa*.

The following are some of the factors which determine the prices :—

1. *Weather conditions—*

Timely fall of rains increases the production and lowers the rates. But if rains are scanty and untimely the prices will go up. The wise, intelligent and shrewd traders always keep in touch with weather conditions not only of loca regions but all over the world. For example, stock-holders at ports, when they found in the last month that the Punjab and United Provinces continue to enjoy favourable weather conditions, began to show keenness for an early disposal of wheat, at prices which cannot but be regarded as definitely unremunerative.

2. *Crop and harvesting conditions—*

The production of wheat, weather and crop condition, yield of harvest and tone of foreign countries are of as vital importance as those of India. For instance when in the last August the report of extensive and serious damage occurred to food, crops in U. S. A. was known ; and that the drought in Europe was calculated to be of great import, the shipment from Karachi started and new levels of wheat prices were conceived. The upward tendency was at once noticed. If foreign countries become tardy there is every hope for speed in the Indian market.

3. *Demand—*

(*i*) *Foreign.*—Foreign demand gives a great stimulus to the *mandis*. With . increased export prices go very high, and both the cultivators and intermediaries will earn more. European firms have also been established in certain *mandis* and increased amount of purchase by them give an indication of more demand and so the market becomes rapid. One of the great reasons for the present low rates of wheat is due to decrease in the foreign demand.

Table VIII

The decrease in export

Year	1930-31	1931-32	1932-33	1933-34	1934-35
Quantity (tons)	196,500	20,200	2,200	2,000	300 up to July

The reason for the decrease in export is due more to internal consumption, increase in foreign production at less cost, than to the inferiority of Indian wheat. But to certain extent admixture of earth, damp, weevil at ports cannot be denied.

(*ii*) In India the demand in big cities and towns increases the wheat rates. For example, demand at Lahore and Amritsar affects Jaranwala and demand in Calcutta, Delhi and United Provinces cities stimulates Hapur, Chandausi and Hathras.

(*iii*) *Local consumption.*—The greater the number of local purchasers the higher will be the price level. The most important local consumers who govern the local prices are the following :—

(*a*) Retail buyers who go in for good quality for home consumption.
(*b*) The existence of flour mills which stock a large amount of wheat and distribute in the form of flour, *maida, suji,* etc.
(*c*) Banks encourage those merchants who otherwise cannot go in for higher rates. Usually seventy-five per cent is advanced by these banks against security of wheat.
(*d*) Some *mandis* enjoy the nearness of military cantonments and thus have higher rates on account of the increased demand.
(*e*) Number of stock-holders. (Dealt separately.)
(*f*) European firms who go in for the purchase when there is export.

TABLE IX

The effect of mills, stock-holders, banks and European firms on the determination of wheat rates in the Lyallpur district

Mandi	No. of mills	No. of banks	Total stock up to 7th Sept. 1934	No. of European firms	Average monthly rate (1934) June	July	August
			lakh bags		Rs. A. P.	Rs. A. P.	Rs. A. P.
Lyallpur	4	5	3½	1	2 1 9	2 0 8	2 0 7
Jaranwala	3 (but do not stock)	3	2	1	2 1 8	1 15 7½	1 15 11
Gojra	...	2	2	3	2 0 0	1 14 ½	2 0 ½
Toba Tek Singh	...	2	1½	3	1 15 5	1 13 7½	1 15 0

Prices are high at Lyallpur because of mills, greater storage capacity, and retail purchasers ; and at Jaranwala because of cantonment and is despatched to Lahore. Statement showing the daily wheat arrival and various consumers is given in Appendix I.

4. *Foreign and internal quotations*—

The current prices of wheat both in the foreign and internal *mandis* are daily communicated among themselves and this has tremendous influence in determining the daily prices. These quotations are either published in some daily business paper, or received by *artias* directly through telegrams, telephones and private

letters. The Punjab and the United Provinces *mandis* are dictated by the port markets when there is an increased export, otherwise Karachi and Bombay follow the internal *mandis*. [*See* Appendix II.]

5. *Railway and shipping freights*—

If the railway freights are decreased the supply at the required station will be at less cost and so demand will increase. For example, last month when it was rumoured that N. W. R. authorities are going to reduce railway freights for Karachi the rate of wheat went up in the Punjab *mandis* with an average difference of 0-0-9 per maund.

Similar is the case of shipping freights. But this comes into play only when wheat is exported.

6. *Storage*—

By storing wheat the demand is kept up and prices remain steady. The usual season of storing starts with April and lasts up to August.

TABLE X

The present stock at various mandis

Name of *mandi*	Stock estimated up to the 2nd week of September 1934
	lakh bags
Lyallpur	3½
Jaranwala	2
Toba Tek Singh	1½
Gojra	2
Okara	2½
Amritsar	2
Kotkapura	3
Karachi	20
Hapur	7
Calcutta	5
Bombay	6

The stock is stored in *pacca kothas*—godowns—each containing 250 bags.

TABLE XI

The cost of storing

Mandi	Rent	Cost of cleaning
		Rs. A. P.
Lyallpur	Rs. 2 to Rs. 3 per *kotha* p. m.	0 0 3 per bag
Okara	Re. 1 to Rs. 2 per hundred bags p. m.	0 0 3 ,, ,,
Amritsar	Rs. 7-8 per *kotha* p. m. chargeable for 6 months.	0 8 0 per *kotha*

In the United Provinces wheat is stored in under ground pits. Each pit contains 700 maunds of wheat, and out of that 100 maunds are spoiled.

Rent for storage varies from Rs. 5 to Rs. 10 per pit for the season. The *artias* prefer pits to *kothas* because wetness increases weight, and thus the quality spoiled is fully recompensed by the increase in weight.

Elevator—

The elevator is a scientific and modern method for storage. The only elevator built at Lyallpur has proved an utter failure because of the following reasons :—

1. It was lent to a firm.
2. The treatment of the managing body was not cordial.
3. A decrease in the original weight of wheat stored there was noticed after it was taken out.
4. It was time of political unrest and the merchants did not like to deposit lest it should not be usurped.
5. It was very expensive.

15. SPECULATION

The use of speculation or 'future rates' called *satta* in vernacular has become so common and popular that almost all the leading *mandis* practise it. Those *kachcha artias* who do not practise it are really governed by its fluctuations.

The *satta* is practised even when there is no wheat in the *mandi*. The brokers (*dalals*) who move from shop to shop are very clever in making bargains. The rates are fixed after consulting the speculation rates of other important *mandis* and local demands. These quotations are communicated by telegrams and telephones. The use of telephone at Amritsar, Hapur and Lyallpur is very common. The *satta* is often played blindly and the sellers and the buyers are often deceived. The speculators have also to bear in mind the charges to be paid as rent, interest, damage and shortage.

When the sellers and the buyers have settled the bargain the *dalal* reports and records the settlement with the chamber of commerce or the company as the case may be, and then his responsibility ceases. Both the *dalal* and the company get their commission. The company keeps a certain portion of the price as margin money and in case the *satta* rates go down and if the difference of loss to the buyers exceeds his deposit, he will be called upon to pay the difference otherwise his bargain is liable to be cancelled. On the other hand if the rates go up the difference will be credited to his account.

The seller issues a delivery order usually between the 1st and 15th day of the month for which the *satta* is fixed, and after that the buyer must get the stock weighed within next 5 days. If the seller is getting profit on account of low rates he hands over the wheat to the buyer. If he loses even then he has to produce the wheat but if he does not keep the stock he is doomed and will have to undergo a heavy loss. These *satta* companies are duly recognised and the speculation is allowed only on the ready stock. But the practice is common by which *satta* is carried on without keeping an equal stock and thus the *satta* players run a great risk. This practice has actually ruined many an *artia* and even the once most influential and powerful one. Although many merchants connected with *satta* are genuine wheat merchants, there are many others who indulge in this business in purely gambling spirit to a mass wealth.

In order to trap other *artias*, the leading *ar tas* often make fool of others. Almost in every *mandi* I have heard *artias* complaining against big *artias*, like Mukant Lal, and Musadi Mal, etc., of Hapur for they actually command the Indian wheat market. Because of their enormous richness they at once start purchasing an exceedingly large stock of wheat and thus raise the rates, stimulate the competition and put other *artias* into difficulties. They go on storing wheat in every *mandi*. On the other hand most of the *artias* go on contracting *satta* bargains and when the delivery time comes they are unable to supply the buyers and thus have to suffer a heavy loss. So they depend upon big *artias* who are the sole owners of the stock and who begin to release it on higher rates,

TABLE XII

The rate of margin money deposited with the satta *companies*

Name of *mandi*	No. of *satta* companies	Money deposited
		Rs. A. P.
Lyallpur	2	1 8 0 per bag. *Satta* is held on at least 25 bags
Okara	2	50 0 0 minimum *satta* is held on at least 100 bags
Amritsar	2	100 0 0 per *satta*. Each unit of *satta* contains 500 maunds
Hapur	3	..
	(1) Chamber of commerce . .	200 0 0 for 25 tons
	(2) Company .	150 0 0 for 25 tons
	(3) Bapar Co.	50 0 0 for 200 maunds

Ready rates are determined by the *kachcha artias* only when *satta* rates are known. Daily rates are usually fixed from anna 1 to annas 4 less than future rates. [*See* Appendix III.]

TABLE XIII

The average monthly rates for the last three months in the important wheat mandis

Mandis	June	July	August
	Rs. A. P.	Rs. A. P.	Rs. A. P.
Lyallpur	2 1 9	2 0 8	2 0 7
Gojra	2 0 0	1 14 ½	2 0 ½
Jaranwala	2 1 8	1 15 7½	1 15 11
Amritsar	2 4 9½	2 4 ½	2 2 9
Okara	2 1 8½	1 15 1	2 2 ⅜
Karachi	1 13 3½	1 12 9½	1 14 4¾
Hapur	2 6 8	2 7 1	2 6 2½
Cawnpore	3 1 0	3 0 8	3 1 6
Chandausi	3 6 0	3 5 9	3 7 0
Batala	2 0 6	2 1 6	2 1 0

The above figures indicate that the prices are high at Chandausi, Cawnpore and Hapur, because of keener competition, more storage and greater demand for United Provinces, Bengal, etc. Rates are high at Amritsar because of less production in the district, greater competition, more wealthy people and presence of mills. Reasons of high rates of Lyallpur have already been explained.

Advantages of speculation—

To artias.—1. *Satta* is a medium of trade to them. 2. They may gain enormously, and the rich ones are apt to gain. 3. It stimulates trade to a certain extent.

To satta companies.—Enormous benefits to share-holders is recorded in every *mandi*. The profit at Amritsar is calculated to be from Rs. 2 to Rs. 2-8 per share of Rs. 100 per year. At Okara daily income of the Companies is estimated to be nearly Rs. 700.

To dalals.—They get their commission on an average rate of Re. 0-2-9 per *satta*.

To the government.—The government gets in form of taxation, telephone and telegram fees.

To growers.—Sometimes when big *artias* start wholesale purchase they may get high rates but on the whole growers are worse off.

Disadvantages—

To artias.—Speculations are done blindly and they often lose because of its great risk. The result of *satta* is that there is no cash in the market.

To companies.—*Nil.*

To dalals.—*Nil.*

To growers.—1. It affects them badly because those who have to store they do not take from them rather prefer to bargain through speculation. Thus the demand decreases and the rates go down. 2. Speculation is often done without wheat and so it affects very badly during the months of April to June because if the old stock is not finished by that time prices will still go down. 3. Rates are fixed on *dara*, those who produce best quality are worse off.

Undoubtedly the *satta* trade is a large employing agency and does produce a certain amount of revenue for the Government on the other hand it is entirely non-productive in terms of real wealth.

16. Weighing

Weighing is done by '*tola*' or weighman who may be a permanent or casual worker. The employment of weighmen depends on the *artia* and so in no case can he go against the wishes and injunctions of the *artia*.

Wheat is weighed in lots of 5 seers by means of hand scale. The standard of weight used in these *mandis* varies differently (for details *see* Appendix IV).

Tolas are paid by the sellers. (The rates charged by him are given in Appendix V.)

The buyer is authorised to check the correct weighing of his bags. The usual custom in all the *mandis* is to check any one bag out of ten bags. This is done by means of weighing machine. If the difference in weight is less than half a seer in that particular bag, a like deduction is made in every other bag of the lot. But when the weight is still less than half a seer, an extra ½ seer of wheat is levied as penalty for each bag. But if it is excess nothing is reported.

Though *tolas* are responsible for the correct weighing of the wheat, yet very few of them are honest. They can do lot of mischief and more of that if the *artia* give him any hint. The *tolas* often join the buyer through the *artia* and add an average of one seer of wheat in each bag. He can also add a bag or two to the total number of bags of one whom he wants to favour.

This process is never followed by the illiterate cultivators who may be even on the spot. The *tolas* however cannot play these tricks with vigilant *baparis*.) Moreover the weighman is supplied with an umbrella at the cultivator's expense to cover him, while weighing the produce. Thus the seller suffers for the mistake in weight as well as in supplying for weighman's comfort. The cultivator again suffers on account of inaccurate and often unreliable weights and measures.

17. Various *mandi* deductions

All the intermediaries and functionaries have to be paid either in cash or in kind. These recipients are of different nature, some of them get for the services rendered and other because of the custom is prevalent.

(Appendix II shows in detail the charges made by these different persons.)

Following are the various kinds of deductions :—

1. *Arit*.—This is the commission paid to *artia* by the seller for effecting the sale of his wheat. It is quite reasonable to get some fee but the rate of charge is certainly high as compared to the present income derived by the cultivators.

2. *Dalali*.— *Dalali* is the commission paid to the *dalal* (broker) by the buyer for having settled the bargain on his behalf.

3. *Dami*.—It is a customary charge apparently paid by the buyer to the *artia* for no special reasons. The fact is that the buyer gets an extra wheat and for this he pays a small amount to *artia* called *dami*. The incidence of this really falls on the seller. In fact, the *artia* and the buyer join hands to rob the seller.

4. *Chungi*.—It is paid by the seller to the buyer's labourers.

5. *Kat*.—It is a discount on cash payment. Usually the buyers are allowed three days for payment of the wheat purchased. But if they pay immediately or before 5 P.M. on that day, they pay at a discount rate. Thus the cultivator actually receives less than his due.

6. *Karta.*—This deduction is made from the seller to cover for the dirt, dust and moisture in the wheat.

7. *Rolai.*—It is a charge for rolling the wheat and is paid by the seller.

8. *Tolai.*—This is weighman's charge as explained above. It is paid by the seller and at some places like Okara it is paid by the buyer ; but even there seller has to pay in kind.

9. *Palladari.—Palladar* is a name for a labourer who holds the bag open for the weighman to put in the weighed wheat and afterwards sews the bags. He also does loading and unloading in the *mandi*. He is also paid by the seller.

10. *Shagirdi.*—This again is an extra burden upon the seller who pays to the *artia* for the upkeep of the establishment of his shop.

11. *Chhanai* (cleaning).—This is an alternative to '*rolai*'. When dirt is suspected in wheat buyers can get the wheat sifted through sieve and the seller has to pay for it.

12. *Mandi functionaries.*—Deductions are made in every *mandi* for the *mandi* functionaries. These are :—

(*a*) *Chuhra* (sweeper).
(*b*) *Mehra* (waterman).
(*c*) *Chaukidar* (watchman).

These men are paid by the sellers for their comfort, but hardly in any *mandi* they serve them. These people are servants of *artias* and work for them and always look to their convenience. They are paid at some *mandi* in cash and others in kind.

13. *Charity deductions.*—Deductions are also made from the sellers for the charity purposes. These are :—

(*a*) *Dharmao.*
(*b*) *Goushala.*
(*c*) *Mandir.*
(*d*) *Beggars.*
(*e*) Cooks of *artias.*
(*f*) On other special occasions like Dosehra and 'Kasni'.

Though these deductions are absolutely unnecessary yet the convention is so strong that the seller is bound up. *Dharmao* is a charge for '*Dharmkhata*'—religious charity, for the upkeep of religious institutions ; but no regular account is kept and the *artia* often usurps the amount. Similar is the case of other items.

In the Central Provinces and Berar there is a practice that a person who brings '*Adthyas*' letter from the post office, is also paid by the seller. Again, during the wheat season the *artia* makes payment in notes ; but if the cultivators ask for silver an additional discount which varies from As. 3 to As. 8 per hundred rupees is also charged.

14. *Samples.*—Considerable amount of the seller is wasted by taking out the wheat as sample.

Thus it would be clear that no fair return can be assured to the cultivator for his produce when such unreasonable and unjustified deductions are charged to the seller's account. In the days of higher rate they may have seemed trivial but in these days these deductions almost eat away the only possible profit that the cultivator might have had. The cultivators are bound by these conventions and cannot evade them.

18. The co-operative methods

In order to avoid such exhorbitant deductions, co-operative shops are being tried in certain *mandis*. These shops are controlled by the co-operative department and are managed locally by a government appointed manager who gets a fixed salary. These shops only effect the sale of the cultivators' wheat and do not indulge into speculations.

This scheme aims at the following advantages to the growers :—

1. Only necessary deductions, with lowest possible rates are charged. For details *see* Appendix V-B.

2. More conveniences to the cultivators are given.

3. No corruption through weighman or broker is possible.

4. These shops give receipts to the cultivators when they bring the wheat whereas the *artia* does not. If *artia* likes he can deny the receipt of wheat. At Gojra (Punjab) the cases have actually occurred when the *artias* denied having taken the wheat.

In spite of the above advantages, cultivators do not go to the co-operative shops for the following reasons :—

1. Co-operative shops do not lend any advance. Cultivators care more for advance than for any concession.

2. Even when giving advance co-operative shops demand repayment in cash whereas the *artia* can be satisfied in other form, *i.e.*, taking away the cultivators' produce or bullocks.

3. Because of their traditions and custom they prefer to go to *artias*. As his father and grandfather had been going to *artias* he too must go to him.

4. The *artia* by his outward sympathy, tact and talk influences the cultivator that he always consider for his benefits and thus entraps him.

At Okara (Punjab) there are two private institutions whose aims coincide with these shops.

(i) *Zemindars' Co-operative Society, Limited.*—It includes leading *zemindars* of its district as its members. They are its shareholders, with

Col. E. H. Cole as its President. It aims to promote the general economic interests of its members by the following means :—

1. To arrange for the sale of wheat in common, of members produce to the best advantage.
2. To arrange for the purchase in common, of all agricultural and house hold requirements of its members.
3. To provide funds by loans, debentures or otherwise for carrying out the purpose of the society.
4. To encourage and facilitate amongst its members the improvement of agriculture.

(ii) *The Producers' Trading Company* (*Khanewal*) *at Okara.*—Members have their fields and farms both on lease and free, and they similarly dispose of their stock through their own company.

These types of private concerns are unquestionably a boon to their members and are certainly desirable in all parts of India.

PART II.—WHETHER SUCH PRICES NORMALLY CONSTITUTE A FAIR RETURN TO THE GROWERS

Expenditure and income of the wheat growers

Under these various handicaps to the cultivators in addition to his own illiteracy and ignorance it is hardly possible to think of a fair return of his produce, The various deductions in *mandis*, the hardship and difficulties which he under—goes in conveying his produce to the *mandis*, the tacts and tricks played by the different intermediaries, and the ill-treatment he receives at the hands of various functionaries speak of his miserable plight. To this is added the low level of rates, due to the absence of foreign demand and the world wide economic depression.

The state of their misery can be brought home by comparing the cost of productions with the total income at the present rate of wheat.

The balance sheet given below is framed from the records of labour, returns and expenses incurred, on producing of crops in the government farm about 3 miles from Lyallpur. The following are items that enter into the cost of production :—

1. *Land revenue.*—This includes government dues local rates and *lambardari* fee.

2. *Manual Labour.*

3. *Bullock labour.*—This includes interest and depreciation on the value of bullocks, feed and any other miscellaneous charges such as shoeing. Bullocks are valued at the beginning of year, on that value interest at 8 per cent and depreciation at 12 per cent are charged.

4. *Water rate.*—This is a charge for the use of canal water varying according to the crop grown. For wheat it is fixed at Rs. 5-4-0 per acre.

5. *Seed.*—The improved seeds recommended by the Agriculture Department are used for sowing.

6. *Manure.*—Farmyard manure has been valued at Rs. 2 per cart load.

7. *Implements.*—Implements such as reapers, ploughs, are necessary including their repairs interest and depreciation.

8. *Miscellaneous.*—

(*a*) *Kamins.*—These are carpenters and blacksmiths who repair agricultural implements throughout the year and are paid in kind.

(*b*) *Harvesting.*—During harvesting time casual labourers are employed to help the farmer and are paid either in kind or cash.

(*c*) *Winnowing.*—This also is done by casual labourers and is paid in kind.

Average outturn.—1. For an acre of land it is estimated that an average of 19 mds. 3 srs. 8 chs. wheat is produced.

2. Besides this an average of 32 mds. 17 srs. 5 chs. *bhoosa* is produced.

TABLE XIV

Average cost per acre of producing wheat

	Rs.	A.	P.
Manual labour	5	4	0
Bullock labour	15	0	0
Water rates	5	4	0
Seed	2	5	3
Manure	0	13	8
Implements	4	2	5
Kamins	0	10	8
Harvesting	1	15	3
Winnowing	2	3	4
Land revenue	7	0	9
Total	44	11	5
Carting and hauling for 3 miles	0	11	2
Marketing expenses	1	7	9
Hauling of *bhoosa*	2	0	6
Total expenditure of both wheat and *bhoosa*	48	14	9

Income at the present rate of price :—	Rs.	A.	P.
Price *bhoosa* at the rate of As. 7 per maund	14	3	0
Balance or the total expenditure on wheat	34	11	9
Total income of wheat at the average rate of Rs. 2·1 per maund .	39	5	6
Net income per acre	4	9	9
Net profit per maund	0	3	10

This should be noted that the produce comprises of the best quality, under favourable facilities, and the hauling distance is 3 miles only.

Besides these legal and academic expenditures the cultivator has to undergo other unnecessary expenses in the form of conventional tips to *darogas*, *numbardar*, and *patwaris* and such other officials. This corruptive difference caused by the *artia* and the weighman are not included, which in certain cases are quite considerable. This again is the case of normal course. The situation can be very well imagined if the crop is damaged.

PART III.—THE SUMMARY OF THE POINTS INJURIOUS TO THE GROWERS

1. Inadequate provision of roads and bridges.
2. Lack of any shelter in *mandis* for cultivators and their cattle.
3. Under-cover system of selling the wheat.
4. System of selling in *dara*.
5. Manipulation of the balances in favour of purchaser by the weighman.
6. Presence of 'ring' of middle men. *Dalals* and *artias* fraudulently exploit the cultivators.
7. When an *artia* acts in dual capacity—buyer as well as seller and his natural inclinations are in favour of the buyers.
8. Having settled the rates, the buyers create trouble on account of dust and quality, and get the rates reduced.
9. Treating the different quality of wheat on the same rate if the seller brings after the rate is determined as at Amritsar.
10. Heavy and unfair deductions.
    (*a*) *Rolai* charge in addition to *karta*.
    (*b*) Cleaning charges even when the wheat is cleaned.
    (*c*) *Dharmao gaushala* and other charities.
    (*d*) Unnecessary payment to the cook of *artia*, and his postal messenger.
    (*e*) Incidence of 'kat' on the seller.'
    (*f*) Additional discount on cash as in the Central Provinces.
    (*g*) Waste through sample, etc.

11. Cultivators' interests are not represented in *mandi* administration.
12. Lack of any publication of rates.
13. Lack of co-operative combination of producers.

To these may be added cultivators' inherited drawbacks :—

1. His chronic shortage of capital, and thus having indebtedness.
2. Ignorance, low standard of literacy and lack of bargaining power.
3. Lack of store houses in the villages.
4. Indulgence into ruinous convention like expenses on family marriage and deaths.
5. The substitution of other food crops like maize, barley for wheat.
6. Crop failures.
7. Cattle plague.
8. Small and scattered holdings.

In these circumstances it is not surprising to know that the cultivator does not get a fair return for his produce.

PART IV.—STEPS NEEDED TO ENSURE A FAIR RETURN TO THE GROWERS

1. Transportation and communication be facilitated. Roads and bridges should be improved and where necessary short roads be gradually built. Members of the District Board should be persuaded by the government agricultural officers —who should be its *ex-officio* members —to take up the desired improvements.

2. *Mandi* deductions should be reduced to its minimum, both by government interference and by making the cultivators enlightened.

3. Regular committees to govern the rules and regulations should be formed in every *mandi* and the cultivators should be given full representations. The government marketing officials should from time to time attend such meetings to induce the members for the necessary requirements of the cultivators, *e.g.*, the following are some of the subjects which should be on their programme :—

(*a*) Better and convenient methods of selling.
(*b*) Times of daily transactions.
(*c*) Sheds.
(*d*) Water arrangements.
(*f*) Holidays.
(*g*) Decision of disputes.
(*h*) Site of *mandis*, etc., etc.

4. For a sound and comprehensive policy it is necessary to publish a daily bulletin with full information as marketing conditions, export and import figures arrival at different *mandis* and their consumers, weather and crop reports, forecast both of India and foreign countries. Such commercial gazettes should be published in local vernacular language.

5. Regulation of markets by the government interference is desirable ; knowledge and methods of distribution should be made public to the cultivators through propaganda works and demonstrations. Admixture of dust should be stopped. Efficient grading and group marketing should be started. Licenses should be issued to *dalals* and if they display any serious tricks their licenses should be confiscated.

6. Weights and measures should be standardised and regulated. The weighman should be reliable and honest.

7. Railway freights though at present are not at high rates, but considering the very low level price of wheat it is desirable that the rates be lowered. The result will be that the rates in the country *mandis* will go up and at ports it will be decreased and it may facilitate for the stimulation of exports.

8. The railway should reduce freight for agricultural implements and make arrangements for quick transit. This would profit not only the cultivators but also the railways as they would attract more wheat traffic.

9. System of cover and '*dara*' sale should be substituted by open sale of separate heaps.

10. 'Combination of producers' be formed and encouraged. The number of co-operative sale society should be increased and should be highly organised and skilfully worked. These should be closely controlled and scrutinised by the co-operative department. Institution like the Zemindar Co-operative Society, Limited, Okara, should be taken as a model. These societies should also make arrangements to give advance to the cultivators under certain conditions.

11. Storage should be encouraged at villages. Perhaps the best thing would be to make *pacca* storehouses in villages by the co-operation of the government, village *zamindar* and the co-operative society. The cultivators should share the cost and the government should lend the money. "Pooling" of wheat is desirable. Pooling societies may be formed for this purpose.

12. The government marketing staff with the co-operation of agricultural and co-operative departments should start propaganda work. The following may be the chief items on their programme :—

1. Storage encouragement in the villages.
2. Formation of producers union.
3. Use of better seed and implements.
4. Use of commercial publications.
5. Acquaintance with *mandi* system of bargain by the growers.
6. Need for interest in *mandi* committee by the growers.
7. Propaganda for improved conditions is necessary because often cultivators remain unaware even of the improvements.
8. Need for social reforms.
9. Wheat should be weighed in the village and be stored in bags and when need for its sale arises, it should be conveyed directly.

10. Establishment of agricultural stalls in *mandis.*

11. Manipulation analyses.

12. Growers should go to *mandis* rather than to sell the wheat to the *banias.*

13. Periodical auction as at Okara.

14. Need for education.

13. Land revenue be reduced temporarily or at least the dates of payment of land revenue and water rates should be different so that the cultivators may be able to store the wheat and pay in instalments.

14. *Satta* should be discouraged. This will increase the demand for the ready stock of wheat and the rates will go up.

15. Propaganda campaign is also needed in foreign countries. The various Indian Trade Commissioners should propagate and demonstrate for the demand of Indian wheat. With the increase in production through the Sukkur and Sutlej barrages the need for stimulating the export is essential.

16. Fixing of minimum rates by the government legislation may be another suggestion, but I doubt its practice because it will raise strong protest by the merchants against a managed and artificial rates. Besides it will raise another competition with Australian wheat which with present import duty is unable to be competed.

17. The lowering of the rate of exchange from 1*s.* 6*d.* to 1*s.* 4*d.* may be another proposal. But it involves new international imperial and such complicated problems.

In the end undoubtedly some of these suggestions are urgently needed without further thinking and delay and are bound to bear fruit. But nothing can go on assisting and managing the affairs of cultivators, unless they themselves are moved by their self-will and conscience. This leads us to the most vital and source of all inspiration, namely, the need for education and enlightenment. This alone can change their indifference to their long established and inherited mentalities.

APPENDIX 1.

Statement showing the daily arrival of wheat at Lyallpur and the portion consumed by different purchasers

June 1934 Date	Arrival of wheat in bags	Detail of purchasers: Stock	Mills	Retail	Miscellaneous	July 1934 Date	Arrival of wheat in bags	Detail of purchasers: Stock	Mills	Retail	Miscellaneous
1st	5,800	3,700	2,000	100	...	1st	6,600	4,900	1,500	200	...
2nd	6,700	5,500	1,300	100	...	2nd	6,700	4,600	2,000	100	...
3rd	4,400	3,700	700	...	...	3rd	5,200	2,700	2,400	100	...
4th	7,800	5,400	2,300	100	...	4th	5,100	3,700	1,300	100	...
5th	7,600	4,200	3,300	100	...	5th	4,300	4,200	...	100	...
6th	8,400	6,600	1,700	100	...	6th	2.000	1,200	800	...	...
7th	1,000	300	650	100	...	7th	Market closed due to rain				
8th	7,000	2,100	2,800	100	...	8th	Do.				
9th	6,400	3,900	2,400	100	...	9th	Do.				
10th	6,550	3,700	2,600	200	...	10th	1,800	...	1,300	...	300 Amritsar 200 military
11th	Market closed					11th	Market closed due to last moon				
12th	2,700	1,600	1,100	...	...	12th	3,200	1,000	2,000	100	100 Jail Deptt.
13th	6,400	4,500	1,900	...	...	13th	3,500	1,000	2,000	100	
14th	3,600	2,200	500	200	...	14th	3,700	2,400	1,200	100	...
15th	4,400	3,100	1,300	100	...	15th	3,600	2,700	800	100	...
16th	4,300	1,200	3,000	100	...	16th	4,700	2,800	1,800	100	...
17th	4,100	2,100	1,900	100	...	17th	6,300	3,700	2,500	100	...
18th	3,200	800	2,300	100	...	18th	5,800	3,300	2,400	100	...
19th	2,500	1,900	600	...	...	19th	6,800	4,300	2,300	200	...
20th	3,100	2,400	600	100	...	20th	7,700	4,000	3,600	100	...
21st	3,900	3,200	600	100	...	21st	7,100	3,000	4,000	100	...
22nd	7,900	3 200	4,600	100	...	22nd	7,000	3 100	3,800	100	...
23rd	Market closed					23rd	6,700	3,400	3,200	100	...

24th	7,100	5,100	1,900	100	...	24th	7,300	4,300	2,900	100	...
25th	Market closed due to rain					25th	6 400	3 400	2,900	100	...
26th	Do.					26th	6,600	3,300	3,200	100	...
27th	3,800	400	3,200	100	...	27th	6,500	3,700	2,700	100	...
28th	3,100	1,400	1,600	100	...	28th	4,800	1,900	2,800	100	...
29th	4,100	3,400	600	100	...	29th	5,700	2,700	2,700	100	200 *diswar*
30th	5,100	3,300	1,700	100	...	30th	5,200	2,400	2,700	100	...

This clearly indicates that the major portion of daily wheat arrival is consumed by mills and stockholders.

Appendix II

Statement showing important mandis *governed by different markets*

Lyallpur follows	Karachi and foreign quotations .	When there is export
	Amritsar	
	Hapur	
Amritsar ,, . . .	Liverpool .	All Punjab *mandis* follow Amritsar
	Argentine	
	Chicago	
	Karachi	
	Bombay	
Gojra ,, ...	Lyallpur	
	Karachi	
	Amritsar	
Okara ,, ...	Amritsar	
	Karachi	
	Lyallpur	
	Hapur	
	Bombay	
Jaranwala ,, ...	Lyallpur	
	Amritsar	
	Karachi	
Karachi ,, ...	Liverpool	
	Argentine	
	Chicago	
	Hapur	
	Cawnpore	
	Amritsar	
	Lyallpur	
Hapur ,, ...	Karachi	
	Bombay	
	Calcutta	
	Amritsar	
	Cawnpore	
	Chandausi	
Cawnpore ,, ...	Hapur	
	Bombay	
	Calcutta	
	Madras	
	Chandausi	
Chandausi ,, . . .	Hapur	
	Cawnpore	
	Calcutta	
	Karachi	
	Bombay	
	Hathras	
Hathras ,, . . .	Hapur	
	Cawnpore	
	Chandausi	
	Calcutta	
	Bombay	

APPENDIX III

Statement showing the difference in daily and future rates in the principal Indian wheat mandis.

August 1934	Lyallpur			Amritsar			Hapur		Karachi
	Ready	Speculations		Ready	Speculations		Ready	Future	Ready at 1 P.M.
		Asuj	*Maghar*		*Asuj*	*Maghar*			
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1st	...	2 0 10½	2 2 1½	2 1 0	2 2 3	2 3 3	2 5 0	2 5 3	1 11 0
2nd	1 15 6	2 1 6¾	2 2 9	2 1 6	2 2 7½	2 2 9	2 5 3	2 5 8½	1 12 3
3rd	2 0 0	2 1 9	2 3 0	2 1 9	2 3 0	2 2 9	2 5 1½	2 5 6	1 12 8
4th	2 0 0	2 2 0	2 3 3	2 1 9	2 2 7½	2 3 1½	2 5 9	2 6 ¾	1 12 4
5th	...	2 2 9	2 4 0	...	...	...	2 6 11½	2 7 2½	...
6th	2 1 3	2 3 3	2 4 6	...	...	...	2 7 3	2 7 6	1 14 0
7th	2 1 3	2 3 9	2 5 1½	2 4 0	2 4 10½	2 4 0	2 7 2½	2 7 6¾	1 14 6
8th	2 2 0	2 3 7½	2 5 1½	2 4 6	2 5 1½	2 5 3	2 7 8½	2 7 11½	1 15 3
9th	2 1 4½	2 3 1½	2 4 7½	...	...	...	2 7 0	2 7 3	1 15 3
10th	Last moon	...	...	2 4 0	2 4 9	2 5 9	...	...	2 0 8
11th	2 2 9	2 4 10½	2 6 4½	2 4 0	2 5 6	2 5 1½	2 7 9	2 7 10½	2 0 3
12th	Rain	2 3 1½	2 4 7½	...	...	...	2 7 6	2 7 9	...
13th	2 1 4½	2 3 3	2 4 9	2 4 0	2 4 10½	2 4 7½	2 7 7½	2 7 9	1 15 7
14th	2 1 0	2 3 0	2 4 7½	2 3 9	2 4 6	2 4 6	2 6 9	2 7 ¾	1 15 3
15th	2 1 3	2 3 1½	2 4 9	2 3 9	2 4 6	2 4 3	2 7 5½	2 7 6¾	1 15 4
16th	2 1 0	2 2 9	2 4 4½	2 3 6	2 4 3	2 4 3	2 6 6¾	2 6 10½	1 15 0
17th	2 1 3	2 2 6	2 4 1½	2 3 9	2 4 4½	2 4 3	2 7 4½	2 7 6	1 15 3
18th	Rain	2 2 4½	2 4 1½	2 3 0	2 3 7½	2 3 6	2 6 6¾	2 6 11½	1 14 6
19th	..	...	..	..	..	...	2 6 6	2 7 6	..

APPENDIX III—*contd.*

Statement showing difference in daily and future rates in the principal Indian wheat mandis—contd.

August 1934	Lyallpur			Amritsar			Hapur		Karachi
	Ready	Speculations		Ready	Speculations		Ready	Future	Ready at 1 P. M.
		Asuj	*Maghar*		*Asuj*	*Maghar*			
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
20th	2 0 6	2 2 5½	2 4 2½	2 3 0	2 3 7½	2 4 0	2 6 9¾	2 7 9¾	1 14 7
21st	2 1 3	2 2 7½	2 4 4½	2 3 0	2 3 10½	2 4 1½	2 7 3	2 8 3	1 15 3
22nd	2 1 6	2 2 6	2 4 4½	2 3 0	2 4 0	2 3 10½	2 7 2½	2 8 ¾	1 15 3
23rd	2 0 3	2 1 9	2 3 6	2 2 6	2 3 3	2 3 0	2 6 0	2 6 11½	1 14 6
24th	2 0 3	2 1 10½	2 3 7½	2 1 6	2 2 9	2 3 0	2 6 0	2 6 11½	...
25th	2 0 6	2 1 9	2 3 6	2 1 9	2 2 4½	2 2 7½	2 5 11½	2 6 10½	1 14 3
26th	2 0 9	2 1 7½	2 3 6	...	...	...	2 6 ¾	2 7 0	...
27th	2 0 6	2 1 6	2 3 3½	2 2 6	2 3 0	2 2 7¾	2 5 9	2 6 9	1 13 9
28th	1 15 9	2 1 3	2 3 2½	2 1 6	2 2 ¾	2 2 6	2 5 6	2 6 6	1 13 9
29th	...	2 1 6½	2 3 7½	2 1 6	2 2 5¾	2 2 9¾	2 6 2½	2 7 1½	1 14 2
30th	2 0 3	2 1 4½	2 3 4½	2 2 3	2 2 11½	2 2 6¾	2 5 9¾	2 6 9	1 14 4
31st	2 0 9	2 1 4½	2 3 4½	2 1 9	2 2 10½	2 3 ½	2 6 3	2 7 ¾	1 14 0

APPENDIX IV

Statement showing the rates of charges, system of verifying and standard of weights in the important Indian wheat markets

Name of *mandi*	Rate of *tola*	Standard of weighments	System of checking	System of cleaning	Who pays it ?
	RS. A. P.	Md. Sr.			
Lyallpur . . .	0-3-9 per Rs. 100	2-28 per bag .	2 bags in cart of 20 bags	*Rollai* . .	Cultivator pays it
Jaranwala. . .	0-3-6 „	2½ Mds. . .	1 bag for every 100 bags	Do. . .	Do.
Gojra . . .	0-3-9 „	Do. . .	10 bags for every 100 bags	Do. . .	Do.
Amritsar .	0-3-0 „	2-1½ per bag .	2 bags for 20 bags	½ seer for dirt compensation	Do.
Hapur * . . .	0-2-6 „	41½ seers per Md. in a bag	1 bag for 10-bags cart of 10 bags	1½ pawa more .	Do.
Okara . .	0-3-9 „	40½ seers a Md.	4 or 5 bags for 100 bags	*Rollai* . .	Recovered from dami *i.e.* buyer pays it.
Ambala City . .	0-3-9 „	...	...	1½ seers per bag	Seller pays it.
Ferozepore . .	0-3-6 „	...	Do. .		Do.
Batala . . .	0-0-6 per bag .	...	Do.		Do.
Kotkapura . .	0-8-0 per 100 Mds.	...	Do. .	...	Do.
Karachi . . .	0-0-6 per candy				

* Sometimes *artia* himself weighs, *e.g.*, Hapur.

The rate of *arit* varies from *mandi* to *mandi* and sometimes it varies even in the same *mandi*. When loan is advanced to cultivators the rate of *arit* is more than usual. All depends on *arit*.

APPENDIX V (A)

Statement showing the rates of deduction charged from sellers (cultivators) in various wheat mandis

Name of *mandi*	*Arit* (commission)	*Chungi*	*Kat*	*Karta*	*Rolai*	*Tolai* (weighing)	*Palladari* (Labouring)	*Shagirdi* (Apprenticeship)	*Chhani* (cleaning)	*Mandi* functionaries: *Churha*	*Mandi* functionaries: *Mehra*	*Mandi* functionaries: *Changar*	*Chawkidar*	Charity deductions: *Dharmao*	Charity deductions: *Goushala*
	RS. A. P.	RS. A. P.		RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.					RS. A. P.	RS. A. P.
Lyallpur	1 12 0	0 1 3	...	...	0 0 3 per bag	0 3 9	0 3 9	0 1 3	0 0 3 per bag	In kind about ½ sr. per heap	In kind about ½ sr. per bag	½ sr. per bag	...	0 1 3	0 0 3
Jaranwala	1 1 9	In kind	...	...	Do.	0 3 9	0 3 9	...	0 0 6	Do.	Do.	Do.	...	0 0 3 per amount & in kind	0 0 3
Gojra	0 0 3 per rupee	10 srs. for 100 bags	...	...	Do.	0 2 6	0 2 6	0 1 0	0 0 9	Do.	Do.	Do.	...	0 0 6	0 0 3
Toba Tek Singh	0 0 3 per rupee	Do.	0 1 0 per rupee	...	Do.	0 12 0	0 0 3 per bag	...	0 0 9	Do.	Do.	Do.	...	0 1 3	0 0 3
Okara	0 12 0 to 1 4 0	Do.	0 0 3 per 100 rupees	...	Do.	0 3 9	1 Ch. per Md.	...	...	Do.	Do.	Do.	...	0 1 0	0 0 3 per heap
Batala	0 0 3 per bag	Do.	...	...	0 0 2 per bag	0 0 6 per bag	0 0 4½ per bag	.	0 0 6	Do.	Do.	Do.	½ pice per bag	0 0 6	0 0 6
Ferozepore	1 0 0	Do.	...	½ seer per Md.	...	0 3 6	0 0 4½ per Md.	0 2 6	0 0 3 per Md	Do.	Do.	Do.	...	0 3 9	0 0 3
Ambala City	0 12 0	Do.	...	...	0 0 1½ per bag	0 3 9 to 0 5 0	0 1 3	...	...	Do.	Do.	Do.	...	0 1 0	in kind
Amritsar	1 4 0	0 0 3 per Md.	...	...	0 2 0	0 3 0	0 2 0 to 0 3 0 per Md	0 8 0	0 0 3 per Md.	Do.	Do.	Do.	...	0 1 0	Do.
Hapur	1 4 0	½ a sr. per Md.	...	1-8 per Md.	½ sr. per bag	0 2 6	0 0 3 per bag	...	...	Do.	Do.	Do.	...	...	0 1
Karachi	0 8 0	...	...	...	...	0 0 6 per candy	...	...	...	...	...	...	...	...	...

NOTE 1.—These deductions are charged per hundred rupees except otherwise mentioned.
2.—Besides deductions are charged in kind about ½ a seer per head by ways of sample *inam*, *mandir* and beggars, etc , etc.

Appendix V (B).

Statement showing the deductions charged from the buyers (dalals)

Name of *mandi*	*Dalali* (brokerage)	*Dami*	Total
Lyallpur	0 1 3	0 1 3	0 2 6
Jaranwala	0 1 3	0 1 3	0 2 6
Gojra	0 2 6	0 1 3	0 3 9
Toba Tek Singh	0 1 3	0 3 3	0 4 6
Okara	0 2 0	0 3 9	0 5 9
Batala	..	..	0 12 6 (both)
Ferozepore	0 2 6	..	0 2 6
Ambala City	0 2 6	..	0 2 6
Hapur	0 2 6	..	0 2 6
Amritsar	0 6 0 to 0 8 0	..	0 6 0 to 0 8 0
Karachi.	0 0 6 per candy	..	0 0 6

Note.—These rates are charged for hundred rupees.

APPENDIX VI

Statement showing the various deductions charged by the co-operative shops

Name of *mandi*	*Arit* (commission)	Total wharfing charge	*Chungi* (changer)	*Chhaumi* (clearing or rolling)	*Palladar* (labour)	Charity	*Mandi* functionaries	Sample	No. of shops	Condition of shops	*Dalali* (brokerage)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.						Rs. A. P.
Lyallpur . .	0 8 0	0 3 6	0 1 3	0 3 0 (when it needs)	0 5 6	0 0 3	In kind .	...	1	Fair .	1 4 0
Jaranwala . .	0 12 0	0 3 6	0 2 6 (*changer*)	0 3 0 when it needs rarely	0 3 9	only *Gaushala* in kind ¼ seer per heap	Waterman only in kind ¼ seer per heap	...	1	3rd in rank, about 15 thousand maund wheat transacted	1 5 9
Goira . . .	0 8 0	0 3 9	...	...	0 2 6	...	0 0 9 for *Gaushala*	...	1	Very good reputation and good rates are available From 60-75 cultivators come in season 4 or 5 if ranked	10 15 0 1 2 0
Toba Tek Singh .	0 8 0	0 7 0	1 *outh* per changer	..	0 3 0	...	Waterman and sweeper in kind.				
Okara— 1. Union . .	0 10 0 to 0 12 0	0 3 9	2 ch. per bag	0 0 3 *rolai*	0 2 6 1 ch. per bag	...	In kind .	...	1	Good . .	0 12 6 to 0 14 9
2. (Producers Trading Co. Khanewal)	0 8 0 to 0 12 0	0 3 9	...	0 0 3	0 2 6	In kind .	Do. . .	...	1	...	0 14 9 to 1 2 6

NOTE.—These rates are charged for hundred rupees.

ABSTRACTS

The supply of humus to soils. F. K. JACKSON, Y. D. WAD and V. G. PANSE. (*Institute of Plant Industry, Indore, Bulletin No. 2 of 1934*).

The Empire Cotton Growing Review in April 1934 published an interesting paper under the above title which has since been issued as a bulletin of the Indore Institute. The standard Indore method of compost manufacture was described in 'the Waste Products of Agriculture : their Utilisation as Humus ' by Howard and Wad (Oxford University Press 1931). The present bulletin describes a simplified technique which is worth quoting *verbatim.*

RAIN-WATERED COMPOST

Successful attempts were made in 1931 to make composts with a few simple operations and rain-water alone and were followed by large-scale routine manufacture in 1932 and 1933. Appendix I gives the detailed technique. Farm wastes collected mainly in the dry months are used throughout the year for cattle bedding where possible, and with dung, urine-earth and ashes, are exposed in heaps to the rains. Three turns provide aeration, and the growing of suitable legumes on the moist heaps between turns hasten rotting. The return to the field of its own wastes is thus literally practicable if the heaps are made on its edge.

This modification is perhaps the greatest achievement of the Indore process, and by its use the quantity of manure produced on a holding can easily be doubled or trebled according to the quantity of wastes which can be collected. Within four months a compost results containing 0·9 to 1·25 per cent. nitrogen, potash up to 3 per cent and phosphate about 0·5 per cent. Up to 99·5 per cent passes a sieve of three meshes per linear inch and 97 per cent through one of six meshes.

The balance of nitrogen and organic matter is shown below.

TABLE I

Balance of nitrogen and organic matter in the rain-watered compost process

	Dry matter in lbs.	Nitrogen per cent (on dry weight)	Total nitrogen in lbs.
Initial charge in heaps . .	24,862	0·78	193·44
Compost	10,650	1·04	111·69
Total loss of nitrogen in lbs. . .	Per cent loss of nitrogen	Per cent of compost to charge. Fresh (55·8 per cent. moisture)	Per cent of compost to charge. Dry
81·75	42·20	73	43

In comparison with the standard process, decomposition temperatures are lower, fungus growth is sluggish and scanty, yet crumbling is equally rapid, this being due apparently to other organisms. Four inches of rain penetrates about 6 inches into the heap raising the moisture to 75 per cent, further rain soaks no deeper unless a turn is given, Decomposition accelerates surprisingly following timely turns; with 5 inches of rain before the first turn and 10 before the second, crumbling is far advanced. This brings areas of low rainfall within range, and indeed in the standard process the water required being intimately incorporated and conserved, is equivalent to only about 16 inches of rain over the area of the pit. Effective rainfall of less than 20 inches (controlled by covering the heaps) gave satisfactory results in 1933. Better use of low rainfall would follow initial exposure in shallow heaps, making two into one at the first turn.

The speed of fermentation determines water requirement. Uniform, rapid soaking frequent aeration by turning, and growing legumes on the heaps between turns, all promote quick decay and water economy.

Compost aided by nitrogen-fixing organisms

In rain-watered heaps with excess of cotton and sorghum stalks and sugarcane trash, decomposition is slow, owing both to low nitrogen content and to defective physical texture with associated uneven aeration and moisture. In 1932 the leguminous sann hemp (*Crotalaria juncea*) was grown on such heaps to add nitrogen by fixation. The plants grew only a foot high, but developed a dense mat of roots crowded with nodules after turning, the heaps decomposed to excellent compost as rapidly as those of mixed wastes.

Further tests confirmed these observations, which showed the practicability of (1) intensive nitrogen fixation in routine composting and (2) easy decomposition of refractory wastes poor in nitrogen, like cane trash, without admixture of better material. Sann gave better nodule-development than other legumes tried and was best sown after the first turn. Evidently the quickened decomposition was due, at least partly, to the nitrogen fixed by the sann hemp.

An old problem with sugarcane growers is the disposal of trash—usually burnt with complete loss of valuable organic matter. This material, difficult to rot because of its low nitrogen content (about 0·3 per cent.) and its tendency to pack densely, is now yielding to suitable modifications in treatment, including the growth of sann hemp as a nitrogen fixer.

Appendix

Rain-watered compost from farm wastes: detailed technique

Materials

(1) *Mixed farm wastes* of all sorts—weeds, stalks of cotton, pigeon-pea and sesamum, any inedible or unwanted threshed straw and chaff, sugarcane trash, stumps of sorghum, millets, maize and sugarcane and uneaten fodder residues. Hard materials need cracking: spreading them on a road or cattle track does this, even if on soft land,

(2) *Dung* of cattle, horses, sheep, goats or camels—about $1\frac{1}{2}$ cubic feet at least per cart load (35 cubic feet) of wastes. Larger quantities may be used safely, but excess is uneconomical.

(3) Ordinary *field soil*, preferably taken from where cattle usually stand, whether in a shed or outside—having absorbed urine it is rich in nitrogen. About 3 cubic feet per cart load is enough.

(4) Wood or vegetable ashes, if available, should be added to enrich the compost in potash and to neutralize acids produced in rotting. One cubic foot per four cart loads is a suitable quantity.

Method

Making the heaps.—Mixed wastes (say a cubic yard per bullock) are spread where the cattle usually stand and are renewed daily or every few days. If cattle dung is required for fuel, as in India, up to three-quarters of it can be reserved at this stage—the remainder will be enough for the compost and should be scattered over the bedding before its removal to a convenient well-drained site, where it is made into a heap 8 feet broad, 3 feet high and of suitable length. It should be built to full height in three days to allow the dung to dry rapidly, unless it is actually rainy weather. The necessary soils and ash may either be thrown on top or added in the cattle shed.

It is not essential to use the wastes as bedding, but a mixture of several kinds is very desirable (there are often difficulties in composting single wastes), and, of course the soil and dung must be added. If urine-soaked earth is not readily available ordinary soil may be used, with more dung.

First turn.—When rain has penetrated the heap to 6 or 9 inches depth it is turned with a fork to make a fresh heap at one side or one end of the original heap. The object of this is to mix the wet and dry material; further rain then soaks in better.

Second turn.—After about a month the heap is turned back to its former position.

Third turn.—About a month later the last turn is given.

Turning distributes moisture and ensures aeration; it should be done on a rainy or cloudy day to check evaporation.

The time-table suits a normal rainy season in Central India: if rain is deficient turning should be delayed, and if the heap is not well rotted a fourth turn should be given. The compost is generally ready to use in four months; three cart loads of wastes will make more than a load of compost.

In areas where rainfall is apt to be uncertain, the process is more rapid if a leguminous crop (sann hemp is found most suitable at Indore) is sown on the top of the heaps after the first turn. Whatever growth it makes is mixed with the rest of the heap at the second turn and promotes rotting. If in a district of low rainfall the heap at any stage is obviously too dry for rotting, it may be spread in a shallower layer when rain is falling and when soaked, built up into a heap again.

The bulletin also contains a description of a similar modification of the standard method adapted to canal-irrigated areas of low rainfall and an interesting note on the aim in humus manufacture. (EDITOR).

Polyembryony in rice (*Oryza sativa*). K. RAMIAH, N. PARTHASARATHY and S. RAMANUJAM. (*Ind. J. Agric. Sci.* **5**, 119).

Polyembryony which is believed to be a rare phenomenon in rice, was observed to occur in fairly large numbers at the Paddy Breeding Station, Coimbatore, in a pure line T. 24 and in several hybrid progenies ; the pure line alone exhibiting the feature consistently in the proportion of 1 in 1,000 seeds. Although seeds giving rise to two seedlings were more common, some giving rise to triplets, which is being recorded for the first time in rice, were also observed.

The several cases of polyembryony isolated were classified and described. Among genetically identical twins, besides the normal green, some lethal albino twins were also observed. Genetically different twins included cases where a haploid was found in association with a diploid and a green seedling with an albino.

The occurrence and breeding behaviour of some of the twins are discussed in relation to the origin of polyembryony in rice, and it is tentatively suggested, subject to confirmation by further embryological studies in progress, that the development of more than one embryo sac might also contribute to the origin of this phenomenon. As regards its significance, which is being investigated in more detail, evidences are available, which show it to be a hereditary character. (*Author's abstract*).

Pollination studies in *toria* (*Brassica napus* L. var. *dichotoma* Prain) and *sarson* (*Brassica campest* L. var. *sarson* Prain). ALI MOHAMMAD. (*Ind. J. Agric. Sci.* **5, 125**).

Floral mechanism in *toria* and brown-seeded *sarson* provides few chances for natural selfing and the plants are extensively cross-pollinated. *Andrena ilerda*, *Apis florea*, and *Halictus sp.* are the chief insect pollinators. High amount of self-fertility is due not only to external causes but also to internal ones (self-incompatibility). Artificial self-pollination in buds two to three days before opening gives good pod-setting and seed production. Probable cause of self-sterility is the slow growth of 'self' pollen than of foreign pollen in the stylar tissue. This is accounted for by an inhibiting action which may be due to a secretion produced actively in the stylar tissue between one and two days before and after the opening of flowers. Pollen grains remain viable for about a week and stigmas remain receptive for three days after the flowers open.

Mass-selection has resulted in considerable improvement. Self-fertility behaves as an inherited character and hybridisation between self-fertile and self-sterile forms shows possibility of evolving entirely new and improved self-compatible forms which would eliminate chances of periodic failures of these crops due to insufficiency of insect visitors. (*Author's abstract*).

Studies in Indian barleys—3. Branched ears in barley and their mode of inheritance. R. D. BOSE. (*Ind. J. Agric. Sci.* **5, 155**).

The inheritance of branched-ears in barley was observed to depend on duplicate factors in a cross between Chevalior (2-rowed) and Pusa Type 21 (6-rowed) barleys. Neither the parents nor the F_1 showed this characteristic which made its appearance

only in F_2 and the succeeding generations. The factors for branched-ears segregated independently of the factors responsible for the inheritance of fertility of the ear-head. (*Author's abstract*).

Oil formation in groundnut with reference to quality. J. S. Patel and C. R. Seshadri. (*Ind. J. Agric. Sci.* **5**, 165).

The percentage of oil formed in groundnut seed increases gradually as the seed develops except in the early stages immediately following fertilization and the period just preceding maturity. As the quantity of oil developed increases, the free fatty acid content diminishes. There is also a decrease in the moisture content of the seed and increase in the shelling percentage as the seed develops. The harvest of the groundnut crop even a week before the kernels are fully mature, affects the quality as it enhances the free fatty acid content and reduces the oil content of the material. The practice of early harvest of groundnut especially in South India thus affects its quality and may stand in the way of foreign demand. (*Author's abstract*).

Inheritance of characters in *Setaria italica* (Beauv.), the Italian millet Part VII. Plant purple pigmentation. G N. Rangaswami Ayyangar, T. R. Narayanan, T. Narayana Rao, and P. Seshadri Sarma (*Ind. J. Agric. Sci.* **5**, 175).

Plants of Italian millet are either pigmented (anthocyanic) or without purple pigment (non-pigmented). The former condition is dominant and arises by the basic presence of a factor **P**. There are various manifestations and intensities in this pigmentation. A factor **I** determines a manifestation in intensity. This is dominant to a manifestation in a weaker depth. The degree to which **P** is operative, in addition to be greatly influenced by the presence of **I**, is conditioned by two other factors **V** and **H**, which determine the alacrity with which **P** manifests in the vegetative or earhead parts. The interactions of **P, I, V** and **H** factors produce the diversity of forms characterising varieties of this millet.

Data from over 420 families are presented in support of the above hypothesis. A number of artificial crosses furnish confirmatory evidence. (*Authors' abstract*).

The nature of oxidising catalysts in soil. Fazal-ud-din. (*Ind. J. Agric. Sci.* **5**, 194).

It has been shown quite recently that nitrification in soil in the tropics is more of a photo-chemical than bacterial nature. The soil is believed to act as a catalytic agent In view of the alleged importance of the photo-nitrification, it was thought desirable to investigate the nature of photo-catalysts in soil.

The catalytic action was tried mostly on the oxidation of mono-ethyl-amine and aniline, and the following conclusions were drawn as a result of this study :—

1. Catalytic power varies with different soils.
2. The oxidising power of a catalyst differs with different compounds.

3. Soil fats, waxes, resins and humus act as catalysts.
4. Impure cellulose possesses catalytic power, which increases on its bacterial decomposition.
5. Alcoholic extract as well as aquous extract of plants also show catalytic action.
6. Water soluble mineral matter in the soil, clay, chlorides of potassium, barium, calcium, magnesium, and oxides of manganese, bismuth,* lead, nickel copper and mercury all possess some catalytic power, which is quite well pronounced in the case of bismuth and mercury.
7. Sodium and potassium clays are better catalysts than calcium, hydrogen, magnesium and manganese clays.
8. The bacterial nitrification in mono-ethyl-amine and aniline solutions was negligible as compared to the photo nitrification in the presence of soil. (*Author's abstract*).

Photo oxidation of sulphur. FAZAL-UD-DIN. (*Ind. J. Agric. Sci.* **5**, 207).

Photo oxidation of sulphur was tried in the presence of zinc oxide, animal charcoal and soil. The process was compared to the bacterial oxidation of sulphur in soil. The following conclusions were drawn as a result of this study.

1. Elemental sulphur is oxidised photo-chemically.
2. Zinc oxide, animal charcoal and soil act as photo catalysts.
3. Chemical oxidation of sulphur in soil is negligible as compared to the biological process. (*Author's abstract*).

A statistical examination of the yield of wheat at the Cawnpore Agricultural College Farm, Part I. R. J. KALAMKAR AND SRIPAL SINGH. (*Ind. J. Agric. Sci.* **5**, 344).

For correlation with weather factors a uniform series of field experiments on wheat at the Cawnpore Farm extending from 1885-86 to 1913-14 was selected from the original records. Before trying to estimate the relationship between weather and yield it was necessary to subject the yield data by themselves to a statistical analysis with a view to examine the relationship between manurial treatments, mean yield and the variability of the yields. The present part is confined to a discussion of these results. (*Author's abstract*).

Some observations on seed-setting in a type of tobacco. KASHI RAM. (*Ind. J. Agric. Sci.* **5**, 353).

Under the cold weather conditions prevailing in December and January few capsules are formed in Pusa Type 56 tobacco, but, with the rise of temperature in the succeeding months, a larger number is obtained.

Observations on reciprocal crosses between this type and Type 63 which shows good setting throughout the season appear to indicate that poor capsule formation at low temperatures is caused by the defective functioning of the pollen of Type 56 at such temperatures. (*Author's abstract*).

The role of *Tabanus orients* Wlk. and *Stomoxys calcitrans* Linn. in the mechanical transmission of rinderpest. H. L. BHATIA. (*Ind. J. Vet. Sci. and Anim. Husb.* **5**, 2).

In order to ascertain whether species of *Tabanus* and *Stomoxys* act as mechanical transmitters of rinderpest, a series of eight experiments, four with *Tabanus orientis* Wlk. and four with *Stomoxys calcitrans* Linn. were carried out by the writer during the summer of 1934 at Muktesar. The flies were starved under laboratory conditions for 18 to 24 hours before they were used for the experiments with the object of eliminating natural contamination as far as possible. Only wild flies were used.

For their initial feeds, the flies were induced to bite bulls experimentally inoculated with the virus of rinderpest, such animals being named " controls ". The flies were interrupted in the course of feeding on a " control " and transferred to a healthy animal to complete their meal. The flies were fed singly on infected and healthy animals in all the experiments, and a different number of these were employed in each with the object of discovering the minimum number required to produce infection.

The results with *S. calcitrans* were entirely negative. In one out of the four experiments with *T. orientis*, where a maximum number of 36 infected flies were allowed to complete their meal on a healthy bull, infection was transmitted by these infected flies and the animal developed all the characteristic symptoms of rinderpest. During the progress of the disease, 20 c. c. of its blood were injected into a healthy bull which also developed typical symptoms of rinderpest. The bull which acquired its infection through flies was kept under observation for 21 days after the last day of feeding on it of the infected flies, and being found in an extremely weak condition on the 21st day it was destroyed. In the *post mortem* examination all the characteristic ulcerative lesions were observed in the oesophagus, abomasum and intestines. (*Author's abstract*).

Ova of schistosomes in the faeces of a dog. A preliminary report. M. ANANT NARAYAN RAO, and R. SWAMINATHAN. (*Ind. J. Vet. Sci. and Anim. Husb.* **5**, 23).

The authors publish a case of schistosomic dysentery in a dog and wish to record that schistosomiasis is one of the likely causes of dysentery in the dog in this country The subject of the case first contracted the dysentery in Jubbalpore (North India) where its owner had previously lost three other dogs from a similar complaint. At the time of the publication, the subject is still alive and under treatment ; the diagnosis of the complaint is from the examination of the faeces of the dog and the finding of the schistosomic ova in plenty.

A description of the ova is given—thin shelled, brownish yellow in colour, sub-oval in shape with one side flattened and possessing a small spine at one end which is sub. terminal and inclined slightly towards the flattened side. The description of the ova is followed by a critical examination of its character on the basis of previous findings by Rao and Ayyar (1933) and the authors are definitely of opinion that the ova found in the faeces of the subject are ova of *Schistosoma suis*. The authors also record the report of the owner of the dog that pigs were found in plenty in the *Jheels* where they used to go snipe shooting and opine that their conclusions derived added strength from that report.

A detailed criticism of the published findings of Bhalerao (1934) on the identification of schistosome found in pigs in Calcutta as *S. japonicum* is included in this report. After a comparative study of the published accounts of Rao and Ayyar (1933) Bayliss (1929) and Faust (1930), the authors say that from a morphological point of view, there are reasons to believe that the Schistosome described by Bhalerao cannot be *Schistosoma japonicum*, but only *S. suis*. The authors also draw attention to the absence of snails of the genus Onchomalaina in India—a species so necessary for the intra-molluscan phase of the life of *S. japonicum*. (*Author's abstract*).

On the occurrence of *Stilesia vittata* (Cestoda) in ovines in India. G. D. BHALERAO. (*Ind. J. Vet. Sci. and Anim. Husb.* **5**, 33).

Stilesia vittata has been known in the past to be a parasite exclusively of camels. The host specificity of this cestode was so strictly adhered to, that Southwell in his recently published Fauna Volume refuses to believe that the parasites could have been obtained from the sheep in spite of the fact that his informant had supplied him with the correct information. The writer had on several occasions obtained this parasite from ovines at Muktesar and his experience goes to show that *S. vittata* is a more common parasite of ovines in this locality than *S. globipunctata*. Like some others *S. vittata* is a common parasite of both camels and ovines in this country. (*Author's abstract*).

Helminth parasites of the Indian elephant from the Andamans and Burma. G. D. BHALERAO. (*Ind. J. Vet. Sci. and Anim. Husb.* **5**, 35).

The author records from the Indian elephant from the Andamans and Burma the parasites *Fasciola jacksoni*, *Pseudodiscus collinsi* and *Equinurbia sipunculiformis* and quotes *Anoplocephala manubriata*. Additional data regarding the parasites *Pfenderius papillatus* and *Murshidia falcifer* are supplied. The species *Pfenderius heterocaeca* and *Syngamus indicus* have been thoroughly redescribed since the original description of these species was not satisfactory. A new species of Amphistomatous trematode, *Pfenderius birmanicus*, from Burma has been described and in the discussion following the description of the species the author has proposed the abolition of the genus *Tagumaea* Fukui, 1926 and suggested that it be merged into the synonymy of *Pfenderius* Stiles and Goldberger, 1910. This procedure was thought necessary on account of the fact that the newly discovered species combines the characters of both the genera *Pfenderius* and *Tagumaea*. The definition of the subfamily Pfenderinae has been amended so as to accommodate the new species. (*Author's abstract*).

On two new monostomes (trematoda) from avian hosts in British India. G. D. BHALERAO. (*Ind. J. Vet. Sci. and Anim. Husb.* **5**, 49).

Two new monostomes: *Notocotylus babai* from the cæcum of *Milvus migrans govinda*, Rangoon and *Cyclocoelum sharadi* from the thoracic cavity of *Urocissa farirostris cucullata*, Muktesar, have been described. The new species have been compared with the

related species of their respective genera. The affinities of the new species with those allied to them are thoroughly discussed. *N. magniovatus* Yamaguti, 1934, has been regarded as synonym of *N. attenuatus*. A key to all the known species of *Notocotylus* from the avian hosts has been given. The status of the various genera so far included in Cyclocœlidæ has been reviewed.

This is the first occasion on which monostomes are being recorded from this country. (*Author's abstract*).

The permeability of the goat's placenta to rinderpest virus. P. C. BANERJI and R. N. MOHAN. (*Ind. J. Vet. Sci. and Anim. Husb.* **5**, 64).

It has been shown that the placenta of the goat (and probably ruminant placenta in general), though possessing a relatively high degree of resistance to the passage through it of most substances, will allow a very minute antigen like the ultravisible virus of rinderpest to traverse it from the mother to the foetus and *vice versa*. (*Author's abstract*).

A comparative study of the fungi associated with blight diseases of certain cultivated leguminous plants. ABDUS SATTAR. (*Trans. of British Mycol. Soc., Vol. XVIII, part IV, April 1931.*)

1. Nine fungi causing blight or foot-rot diseases of pea, gram, lentil and vetch (*Vicia sativa*) have been studied.

2. The symptoms of the disease and nature of injury caused, as observed on naturally or artificially infected plants, have been described.

3. A comparative study of the various fungi has been made as regards the following :—

(*i*) Morphology on the natural host and on various artificial culture media.

(*ii*) Response to environmental conditions, such as nature of medium, acidity of medium and temperature.

(*iii*) Manner of spore germination under a variety of conditions.

4. Inoculation experiments by three different methods under glass-house and field conditions have been carried out. The main results were :

(*i*) Each fungus with the exception of *Mycosphaerella pinodes* and *Ascochyta pinodella* is specialised largely to its own host plant.

(*ii*) *Mycosphaerella pinodes* and *Ascochyta pinodella* are the only ones which cause severe foot-rot.

5. A discussion of the experimental results in relation to the taxonomy of these forms is given, and the following conclusions are reached :—

(*i*) The fungus causing blight of peas in India is typical *Ascochyta pisi* Lib.

(*ii*) The fungi isolated from lentil in India and from wild *Vicia sativa* in England are varieties of *Ascochyta pisi* Lib.

(*iii*) The fungus causing blight of gram in India is identical with *Phyllosticta rabiei* (Pass.) Trotter. Reasons are given in support of the transference of this species to *Ascochyta* as *Ascochyta rabiei* (Pass.) Labrousse.

(*iv*) *Ascochyta pinodella* Jones and *Ascochyta pinodes* Jones (perfect stage—*Mycosphaerella pinodes* (Berk. & Blox. Stone) are confirmed as good species and distinct from *Ascochyta pisi* Lib. and *Ascochyta rabiei* (Pass.) Labrousse. The two former are characteristically associated with the foot-rot phase of the disease and are both rather unspecialised in their parasitism.

(*v*) A fungus isolated from peas in India, in association with *Ascochyta pisi* Lib. is considered to be a weakly parasitic race of *Ascochyta pinodella* Jones. (*Author's abstract*).

The occurrence, perpetuation and control of gram (*Cicer arietinum* L.) blight caused by *Ascochyta rabiei* (Pass) Labrousse, with special reference to Indian condition. ABDUS SATTAR. (*The annals of Applied Biology, Vol. XX, No. 4, pp. 612-633*).

1. The importance and distribution of gram blight are described.

2. The field appearance of blight, and the influence of evnironmental factors such as rainfall, temperature, wind and system of cropping on its incidence and development are given.

The occurrence of blight in various parts of India is shown to be highly correlated with the amount of rainfall during the flowering and fruiting periods of the gram crop.

3. It is shown that the gram plant increases in susceptibility with age and is most susceptible at the flowering and fruiting stages. This susceptibility has been found to be directly proportional to the amount of malic acid secreted by the plant on its surface.

4. Germination of spores of *A. rabiei* has been studied in some detail and it has been found that they are favoured in their germination by the presence of N/50-N/25 malic acid or acidified carbon food (pH 2·5).

5. It has been proved that the disease is carried over from one year to another (*i*) by sowing infected seed, (*ii*) by sowing seed mixed with pieces of diseased gram stalks and (*iii*) by diseased plant debris which remain lying on the surface of soil in the fields after the crop is harvested.

6. Measures of control of the disease are given.

The most practicable for the farmers are :—

(1) Use of healthy seed for sowing purposes and (2) destruction of diseased plant debris. (*Author's abstract*).

NOTES

IMPORTATION OF FRUITS INTO INDO-CHINA

In the May (1934) Number of 'Agriculture and Live-stock in India' was published a translation of the Decrees issued by the Governor-General of Indo-China, dated the 8th March and 6th July 1932, regarding the importation of fruits into Indo-China. It is now notified for general information that the following officers are authorised to issue the certificates required under Article 1 of the said Decrees in their respective provinces :—

Province	Designation of officer authorised to issue certificates
Madras	A Gazetted officer of the Entomological Section not below the rank of an Assistant Entomologist
Bombay	Plant Pathologist and Professor of Entomology at the Poona Agricultural College
Sind	Chief Agricultural Officer in Sind
Bengal	Secretary of the Agricultural and Horticultural Society of India, Alipore, Calcutta
United Provinces . .	Deputy Director of Gardens, United Provinces, Saharanpur
Punjab	Entomologist to the Government of the Punjab
Bihar and Orissa . .	Horticulturist, Bihar and Orissa, Fruit Research Station
Central Provinces . .	Director of Agriculture
Assam	Director of Agriculture
North-West Frontier Province	Agricultural Officer
Coorg	Deputy Director of Land Records and Agriculture

2. The Agricultural and Horticultural Society of India, Alipore, Calcutta, will levy a fee at 5 per cent on the invoice value of the consignment subject to a minimum charge of Rs. 5.

IMPERIAL BUREAU OF SOIL SCIENCE: SOIL DEFICIENCIES AND PLANT DISEASES

Technical Communication No. 13 of the Imperial Bureau of Soil Science. Rothamsted, "Soil Deficiencies and Plant Diseases" deals with the border line of plant physiology and soil chemistry. Dr. Jacks and Miss Scherbatoff have collected and summarised the relevant facts from some hundreds of papers and provided a bibliography of 367. This bulletin does not deal with the phenomena associated with nitrogen, potash or phosphatic starvation, but with the pathological conditions which have been described to deficiencies of the so-called minor elements, notably manganese, iron, magnesium, boron, sulphur, copper and zinc.

A handy table of deficient elements, main crops affected and numerical references to the main bibliography considerably enhance the utility of the bulletin (EDITOR).

WHEAT MARKETING IN INDIA

The Imperial Council of Agricultural Research offered a prize of Rs. 500 for the best thesis on wheat marketing. In response to the advertisement twenty essays were received which were judged by a Committee composed of the following three judges :—

1. Diwan Bahadur Sir T. Vijayaraghavacharya, K.B.E., Vice-Chairman, Imperial Council of Agricultural Research.
2. Mr. D. L. Drake-Brockman, C.S.I., C.I.E., I.C.S., Member, Board of Revenue, United Provinces.
3. Dr. L. C. Jain, M.A., LL.B., Ph.D., Professor of Economics, University of the Punjab.

The essays received were examined by the judges who considered that the theses submitted by the under-mentioned two gentlemen were the best and as they were of equal merit they resolved to divide the prize equally between them.

The names of the successful candidates are :—

1. Mr. Abdul Hamid, 343, Grand Trunk Road, Lahore.
2. Mr. J. M. Lobo-Prabhu, I.C.S., Dehra Dun.

The successful theses are published on pages 236 and 251 of this journal.

BIHAR AND ORISSA VETERINARY COLLEGE, PATNA

Notice

The next session of the Bihar and Orissa Veterinary College will commence from the 1st July 1935.

1. Candidates desiring admission should each submit his application on the prescribed form, together with the following certificates in original, so as to reach the principal on or before the 1st June, 1935.

(*a*) Age and moral character certificate from the Head Master of the School at which he last read.

(*b*) University certificate or a certificate from the School or University authorities to show that he has passed the Matriculation Examination.

(*c*) Medical Certificate of fitness from an Assistant Surgeon.

(*d*) Letter from his guardian stating that all expenses incurred by his ward during the latter's period of study at the college will be paid.

(*e*) Letter of identification from some well-known person stating that the candidate is known to him and the statements made in the application form are correct.

2. Government or District Board stipendiaries should in addition to the above each produce a letter from the Director of Veterinary Services, Bihar and Orissa, or from the Chairman, District Board concerned, to whom they should apply in the first instance, stating that their selection as stipendiaries has been approved.

3. Preference will be given to candidates who have passed the I.A. or I.Sc. Examination of a recognised University. A good knowledge of English is essential.

4. Non-stipendiary candidates will have to appear before the Governing Body of the College when called for interview.

5. Fees must be paid in advance according to the scale under rule 8 of the college rules.

6. Candidates will reside in the college hostel from the date of their admission unless specially exempted.

7. Admission forms may be had free on application to the Principal. Prospectus will be supplied on receipt of 0-4-0 by money order for each copy required.

Personal notes, Appointments and Transfers, Meetings and Conferences, etc.

His Excellency the Governor-General in Council has been pleased, under the provisions contained in Rules I and 22 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the DIWAN OF TRAVANCORE as a member of the Imperial Council of Agricultural Research and also as a member of its Governing Body.

His Excellency the Governor-General in Council has been pleased, under the provisions contained in Rules I and 43 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the DIRECTOR OF AGRICULTURE AND FISHERIES, TRAVANCORE, as a member of the Imperial Council of Agricultural Research and also as a member of its Advisory Board.

In consequence of the vacancy caused by the resignation of Khan Bahadur Maulvi Mohammad Obaidur Rahman Khan, the Government of the United Provinces have nominated KHAN BAHADUR SHAH NAZAR HUSSAIN to be a member of the Indian Central Cotton Committee to represent the cotton-growing industry in that Province.

In pursuance of clause (xi) of section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council has been pleased to appoint Mr. CHELLARAM SHEWARAM to be a member of the Indian Central Cotton Committee constituted under the said Act to represent the Karachi Cotton Association, Ltd.

In exercise of the power conferred by sub-section (4) of section 4 of the Indian Lac Cess Act, 1930 (XXIV of 1930), the Governor-General in Council has been pleased, on the recommendation of the Bengal Chamber of Commerce, to nominate Mr. E. H. MARSHALL to be a member of the Indian Lac Cess Committee, to represent the shellac export trade, *vice* Mr. W. G. C. Frith resigned.

Rai Bahadur MALIK CHARAN DAS, Secretary, Imperial Council of Agricultural Research, has been granted leave on average pay for four months with effect from the 16th March 1935 (forenoon) preparatory to retirement.

Mr. Bazlul Karim, of the Imperial Secretariat Service (Class II), an Assistant in the Imperial Council of Agricultural Research, has been appointed to officiate as Secretary, Imperial Council of Agricultural Research with effect from the 16th March 1935, *vice* Rai Bahadur Malik Charan Das, granted leave preparatory to retirement, or until further orders.

Mr. P. M. Sundaram, of the Imperial Secretariat Service (Class II), an Assistant in the Imperial Council of Agricultural Research, has been appointed to officiate as Superintendent in that Department with effect from the 16th March 1935, *vice* Rai Sahib Tej Bhan Bahl on leave, or until further orders.

Mr. A. M. Livingstone has been appointed temporary Marketing Expert, Imperial Council of Agricultural Research, and Agricultural Marketing Adviser to the Government of India with effect from the 1st January 1935.

The following appointments have been made in the Office of the Agricultural Marketing Adviser to the Government of India, with effect from the dates shown against each :—

Senior Marketing Officers

1. Mr. C. B. Samuel, M.A., B.Sc. (Hons.) [1st February 1935].
2. Mr. A. M. Thomson [1st February 1935].
3. Mr. H. C. Javarayya, L.Ag., F.L.S., F.R.H.S. [27th February 1935].

Marketing Officers

1. Mr. B. P. Bhargava, B.Sc., A.M.Inst. B.E. [18th February 1935].
2. Dr. T. G. Shirname, B.Ag., Ph D., F.S.S., F.R. Econ.S. [21st February 1935].
3. Mr. D. N. Khurody, I.D.D.(Hons.) [25th February 1935].

Assistant Marketing Officers

1. Mr. Triyugi Prasad, M.A., LL.B. [1st February 1935].
2. Mr. Farzand Ali Shah, B.A. [1st February 1935].
3. Mr. P. L. Tandon, B.Sc.(Wales), F.R.Econ. S.(London) [1st February 1935].
4. Mr. Hukmat Khan, B.Sc.(Agri.) [1st February 1935].
5. Mr. K. Comarasamy Chetty, B.Sc. (Edin.)[1st February 1935].

6. Mr. S. C. CHAKRAVARTY, B.Ag. [1st February 1935].
7. Mr. E. M. BEE [1st February 1935].
8. Mr. K. GOPALAN, M.A., Dip.Econ., C.H.D., B.Com.(Manchr.), F.R.Econ.S. [1st February 1935].
9. Mr. SHASHI KANT DESAI, N.D.D.(Scot.) [1st February 1935].
10. Mr. FAZAL HAQ, B.Ag., M.Sc.(Reading) [1st February 1935].
11. Mr. NURUL ISLAM [4th February 1935].
12. Mr. Y. T. DESAI, B.Ag., M.Sc.(Econ.)(London), F.R.Econ. S. (Eng.) [20th February 1935].

Syed RIAZUL HASSAN, M.R.C.V.S., Assistant to the Professor of Pathology, Punjab Veterinary College, Lahore, has been appointed Deputy Director, Imperial Veterinary Serum Institute, Izatnagar, with effect from the 5th November 1934.

Madras

Mr. R. W. LITTLEWOOD, N.D.A., I.A.S., Deputy Director of Agriculture, Livestock, has been granted leave on average pay out of India without medical certificate for five months and fifteen days from 1st April 1935.

Mr. T. MURARI, B.Sc., Dip. Rural Econ., Dip. Agri., F.L.S., Temporary Superintendent, Livestock Research Station, Hosur, has been appointed to officiate as Deputy Director of Agriculture, Livestock, Hosur, in Class I of the Madras Agricultural Service, with effect from 1st April 1935, *vice* Mr. R. W. Littlewood granted leave.

Mr. B. RAMAYYA, B.Sc.(Edin.), Deputy Director of Agriculture, I Circle, Vizagapatam, has been granted leave on average pay without medical certificate for two months from 11th March 1935.

Mr. K. UNNIKRISHNA MENON, Dip.Agri., Assistant Director of Agriculture in charge of VI Circle, Madura, has been appointed to a post in Class I of the Madras Agricultural Service and to officiate as Deputy Director of Agriculture, VI Circle, Madura, with effect from 22nd November 1933.

Mr. T. BUDHAVIDHEYA RAO NAYUDU, L.Ag., Assistant Director of Agriculture in charge of II Circle, Guntur, has been appointed to a post in Class I of the Madras Agricultural Service and to officiate as Deputy Director of Agriculture, II Circle, Guntur, with effect from 11th January 1934.

Mr. Y. G. KRISHNA RAO NAYUDU, C.D.A.(Edin.), Assistant Director of Agriculture, Salem, has been appointed to Class I of the Madras Agricultural Service and to officiate as Deputy Director of Agriculture, VIII Circle, Coimbatore, with effect from the date of taking charge.

Dr. T. V. RAMAKRISHNA AYYAR, B.A., Ph.D., F.Z.S., Lecturer in Entomology, Agricultural College, Coimbatore and Officiating Government Entomologist, Coimbatore, has been appointed to be Government Entomologist, provisionally substantive, with effect from 23rd December 1930.

Mr. M. C. CHERIAN, B.A., B.Sc., D.I.C., Lecturer in Agriculture, Agricultural College, Coimbatore, and Officiating Lecturer in Entomology, Agricultural College, Coimbatore, has been appointed to be Lecturer in Entomology, provisionally substantive, with effect from 23rd December 1930, *vice* Dr. T. V. Ramakrishna Ayyar.

Mr. K. C. NAIK, Assistant to the Fruit Specialist, Agricultural College, Punjab and Officiating Horticulturist, Bihar and Orissa, has been appointed to be temporary Superintendent, Fruit Research Station.

Mr. G. GANAPATHI AYYAR, Assistant, Chemistry Section, has been appointed to officiate as Assistant Agricultural Chemist, Coimbatore, in Class I of the Madras Agricultural Service, with effect from the date of taking charge.

Mr. K. S. VISWANATHA AYYAR, B.A., Assistant Agricultural Chemist, Coimbatore, has been granted a further extension of leave on half average pay without medical certificate for four months from 14th January 1935.

Mr. S. N. Venkataramana Ayyar, Upper Subordinate, IV Grade, has been appointed to Class I of the Madras Agricultural Service and to officiate as temporary Assistant Marketing Officer, with effect from the date of taking charge.

Mr. M. P. Kunhikutti, Upper Subordinate, II Grade, has been appointed to Class I of the Madras Agricultural Service and to officiate as temporary Assistant Marketing Officer, with effect from the date of taking charge.

Bombay

Dr. W. Burns, D.Sc., I.A.S., Director of Agriculture, has been granted leave on average pay for two months and thirteen days combined with leave on half average pay for four days with effect from 2nd February 1935, or the subsequent date on which he may be relieved.

Mr. B. S. Patel, N.D.D., N.D.A., C.D.A.D., I.A.S., Deputy Director of Agriculture, Gujarat, has been appointed to officiate as Director of Agriculture, *vice* Dr. W. Burns, proceeding on leave.

Mr. C. S. Patel, on return from leave has been appointed to officiate as Deputy Director of Agriculture, Gujarat, *vice* Mr. B. S. Patel.

Mr. V. A. Tamhane, M.Ag., M.Sc., Agricultural Chemist and Soil Physicist and Local Officer, in charge of the Sakrand Agricultural Research Station, has been appointed to officiate as Chief Agricultural Officer in Sind during the absence on leave of Mr. W. J. Jenkins.

Mr. G. P. Patil has been appointed to officiate as Professor of Agricultural Economics, Poona Agricultural College, *vice* Dr. T. G. Shirnamo, appointed Marketing Officer in the Office of the Agricultural Marketing Adviser to the Government of India, pending further orders.

Mr. N. Narayana has been appointed to act as Assistant Professor of Chemistry, Poona Agricultural College, in the Bombay Agricultural Service, Class II, with effect from 1st March 1933 and placed on probation for a period of two years.

Mr. Y. N. MARATHE has been appointed to act as Deputy Director of Veterinary Services, Bombay Presidency, *vice* Khan Saheb J. D. Buxy, retired.

United Provinces

Mr. J. A. MANAWWAR, M.Sc., Assistant Director of Agriculture, Sarda Circle, Lucknow, has been appointed to the temporary post of Officer on Special Duty for performing the duties of Provincial Marketing Officer, with headquarters at Lucknow, with effect from the date he assumes charge of the duties of the post.

Mr. J. G. BURNS, Garden Overseer, Kumaun, has been appointed to hold the temporary post of Superintendent, Government Gardens, Chaubattia.

Punjab

Mr. A. GHIAS-UD-DIN AHMAD, B.Sc (Agri), M.Sc (Lond.), Bar-at-Law, F.R.H.S., M.R.A.S., Officiating Assistant Professor of Botany, Punjab Agricultural College, Lyallpur, has been appointed Officiating Assistant Physiologist, Botanical Section, Punjab Agricultural College, Lyallpur, with effect from the 1st December 1934, consequent on the transfer of one of the two posts of Assistant Professors of Botany to the Research side of the Botanical Section.

Sardar Bahadur SARDAR JAGAT SINGH, B.A., M.Sc., Assistant Professor of Chemistry, Punjab Agricultural College, Lyallpur has been granted leave on average pay for eighteen days and in continuation leave on average pay on medical certificate for three months and twenty-two days, with effect from the 23rd December 1934.

Burma

Mr. F. D. ODELL, M.A., I.A.S., has been appointed to be Marketing Officer, Burma, with effect from the 1st February 1935.

Mr. SAW TUN, B.Ag., Assistant Director of Agriculture, Myingyan Circle, Meiktila, has been granted leave on average pay for three months with effect from the 15th January 1935 or the subsequent date on which he avails himself of it.

Mr. BA ON, D.Sc., B.Ag., Senior Agricultural Assistant, Mahlaing, has been appointed to officiate in the Burma Agricultural Service (Class II), and has been posted as Assistant Director of Agriculture, Myingyan Circle, Meiktila, in place of Mr. Saw Tun, Assistant Director of Agriculture, proceeding on leave.

Mr. R. M. RAO has been appointed to the temporary post of Assistant Rice Research Officer, Burma, with effect from the 5th February 1935.

Mr. J. SMITH, B.V.S., Class I, Veterinary Research Officer, has been granted leave on half average pay for six months and twenty-four days in continuation of the leave already granted to him. Mr. Smith has been permitted to retire from the service of Government on the expiry of the leave.

Central Provinces

Mr. LAXMI NARAYAN DUBEY, Extra Assistant Director of Agriculture, Chhindwara, has been granted leave on a verage pay for two months on Medical Board certificate in extension of the leave already granted to him.

On return from the leave granted to him Mr. D. G. MEHTA, B.Ag., Extra Assistant Director, assumed charge of the temporary post of Assistant Marketing Officer in connection with the scheme for the improvement of marketing in India, with effect from the 11th February 1935.

Rai Bahadur R. V. PILLAI, G.B.V.C., Deputy Director of Veterinary Services, Central Provinces, has been granted leave on average pay for eight months (out of India), with effect from the 25th March 1935.

Rai Sahib GOURISHANKER SHRIVASTAVA, Assistant Director of Veterinary Services, Berar Division, has been appointed to officiate as Deputy Director of Veterinary Services, Central Provinces, *vice* Rai Bahadur R. V. Pillai, on leave.

Assam

Mr. SATYENDRA CHANDRA DATTA, Superintendent of Agriculture, Surma Valley, has been appointed temporarily as Deputy Director of Agriculture, in Class I of the Assam Agricultural Service, with effect from the 1st February 1935, and has been placed in charge of the Surma Valley Circle.

On being relieved by Mr. Satyendra Chandra Datta, Deputy Director of Agriculture, Mr. Fazlul Haque, M.R.A.S., Dip. in Agric., Deputy Director of Agriculture, Surma Valley Circle, has been transferred to Jorhat and has been placed in charge of the Upper Assam Districts Circle.

On being relieved by Mr. Fazlul Haque, Deputy Director of Agriculture, Mr. Laksheswar Borthakur, Deputy Director of Agriculture, has been transferred to Gauhati and has been placed in charge of the Lower Assam Districts Circle.

REVIEWS

Scientific Horticulture (formerly the H. E. A. Year Book), Vol. III, 1935. Price 3s. 6d., postage extra. Published by the Horticultural Education Association.

The Horticultural Education Association now call their annual journal *Scientific Horticulture*—a title which more accurately represents its contents. The Honorary Editor, Mr. R. T. Pearl of the Wye Agricultural College, is also joint author of two of the special articles which appear in this number. Dr. Wallace's presidential address to the Association is entitled 'Science and Fruit Growing'—an appropriate choice, for it is now 40 years since the oldest fruit research station in England was opened at Woburn by the Duke of Bedford and by Mr. Spencer Pickering whilst 1934 also marked the 'coming of age' of the youngest research institute at East Malling—which is already well known to many Indian readers. 'Science and Fruit-growing' was the title of the publication by the Duke of Bedford and Mr. Spencer Pickering issued in 1919 when Woburn Station was closed down after 25 years of experimental work and summarised the position as it then was. In his address, Dr. Wallace shows what an important bearing these early results have had on more recent progress. He concludes by pointing out that there is one side of the great liaison between science and fruit-growing which must not be neglected and that there is great need for a sound educational structure which will advance with the times. He ably points out that a position has now been reached when fruit research can provide the data both for the highest type of scientific course in Pomology in a University and for the more practical courses in fruit-growing which are required for the various grades of fruit-growers and workers. Very great progress has been made in this direction by the Long Ashton research station of the University of Bristol, of which Dr. Wallace himself is Deputy Director, and to which several Indian students owe a debt of gratitude.

Messrs. Bagenal and Pearl have contributed a most useful summary of the Royal Horticultural Society's Conference on Apples and Pears, which was held at Crystal Palace in September 1934. Among important papers read at this conference mention may be made of 'Orchard Factors affecting Fruit Quality' by Dr. Wallace; 'the Storage of Apples' by Kidd and West; and 'Rootstocks for Pears, by Mr. R. G. Hatton, Director of the East Malling Research Station. The journal also contains a brief note by Sir Albert Howard on the utilisation of the waste products of horticulture as humus and a reference to the now familiar 'Indore Process of Compost-making.' Messrs. Pearl and Hart contribute an excellent summary 'Twenty-one years fruit research at East Malling'.

The work of this Fruit Research Station is well-known to many horticulturists in India through the medium of the horticultural abstracts published by the Imperial Bureau of Fruit Production which has headquarters at East Malling. The station is famous the world over for the work it has done on rootstocks and for the experimental technique which it has developed. Of special interest is the modern lay-out for a manurial trial with apples which was described in Technical Communication No. 2 of the Imperial Bureau of Fruit Production. In view of the discouragement which has attended similar experiments elsewhere particularly in the United States, the salient points of the East Malling methods will bear recapitulation here. They are :—

(*a*) The elimination of inherent variation of the experimental trees by (*i*) the use of standardised clonal rootstocks and carefully rogued varieties true to name ; (*ii*) the utmost care in grading the plants for uniformity and freedom from diseases.

(*b*) Comprehensive, complete and accurate measurement of the individual tree's growth, flowering, cropping and health record.

(*c*) Scrupulous attention to details of management, including a forward policy of disease and pest control.

(*d*) Improved plot lay-out designed to eliminate positional factors and soil differences.

(*e*) Systematic soil survey prior to planting.

Nor should the contributions of the East Malling Research Station to our knowledge of plant physiology go unmentioned. The work of Rogers on the root-systems of apple trees is furnishing information of great value in relation to tree management and nutrition, whilst the same worker's direct observations on tree-root growth, where the root in its natural surroundings is studied with the microscope by means of special observation trench, promises a better understanding of the trees responses to external conditions. Knight's studies of root-shoot ratio and the effect of differential root and shoot pruning treatment promises to provide a clearer picture of what is likely to happen when a newly-planted tree is pruned.

These examples must suffice and as in former years, *Scientific Horticulture*, to give it its new title, will be found of the greatest use to all interested in the scientific production of fruit, vegetables and flowers (EDITOR).

Lac and the Indian Lac Research Institute. By DOROTHY NORRIS, P. M. GLOVER AND R. W. ALDIS. *Published by the Lac Research Institute, Namkum, Ranchi, Price Rs. 2-8-0.*

Lac is one of the village industries whose importance was emphasised by the Royal Commission on Agriculture which pointed out that the chief obstacles in the way of its development were :—great fluctuations in price, an excessive number of middlemen between the cultivator and the Calcutta market, competition from synthetic substitutes, the absence of any standardised product, and the liability to

loss from insect pests. Lac cultivation is of special importance in the Chota Nagpur Division of Bihar, the Feudatory States of Orissa and part of the Central Provinces and Central India. Generally speaking these are 'precarious' areas agriculturally so that any addition to the agriculturists income is doubly important. The manufacture of shellac is an ancient Indian industry. Lac production is mainly confined to India though appreciable quantities are produced in the Far East, mainly in Siam. The manufacture of shellac, and of the less important forms Button Lac and Garnet Lac, is practically an Indian monopoly and most of the stick-lac from the Far East is marketed through Calcutta.

After a concise description of the industry itself the authors describe the events leading up to the establishment of the Lac Research Institute at Namkum, five miles from Ranchi, the headquarters of the Chota Nagpur Division. Funds were provided by a small cess on lac exports. The research sections of the Institute are the Entomological, the Bio-chemical and the Physico-chemical. Broadly speaking, the first two are concerned with improvements in the efficiency of lac production; the latter with improvements in manufacture, in methods of analysis and in new and improved methods of lac utilisation. The former is the best remedy for low prices, the latter has become a primary necessity in view of the competition of synthetic substitutes. In the electrical industries, in varnishes and in mouldings the competition of synthetic products has become of great and increasing importance and it can only be met by increased efficiency in production, manufacture and marketing—including scientific service to consumers such as is so freely offered by the large 'synthetic' combines.

The authors give a readable account of the activities of the Institute and of the results of research of which only a few can be mentioned here. On the production side, definite advances have been made in plantation management especially in pruning. The best lac is produced on the *Kusum* tree (*Schleicheratrijuga*) but as managed by the cultivator regular crops are not obtained and the tree has often to be rested for two years. By the Institute's method, a crop can be obtained once in every 18 months and the trees show an increasing 'frame' so that the cropping area of the tree is gradually increased. The introduction into Chota Nagpur of the alternative host *Khair* (*Acacia catechu*) is stated to be a great success affording an increased supply of lac of the same high quality as is produced on *Kusum*.

The Entomological Section has worked out a simple method of forecasting swarming which enables the brood lac to be cut at the right time, instead of weeks beforehand, and a better infection obtained. Simple changes in cultural methods enable the loss of lac from insect enemies to be greatly reduced. The biological control of one of the major predators of lac, *Eublemma amabilis*, a Noctuid moth appears to be a practical possibility as the parasite *Microbracon tachardiae* can be bred artificially in numbers. Amongst discoveries on the industrial chemical side may be mentioned improvements in the indigenous method of shellac manufacture

and the successful use of the bye-product "kiri" both for the production of bleached lac and for the manufacture of a moulding powder. Much work has also been done and published in the form of research notes, on the improvement of shellac for use in varnishes. A description is given of the work of the London Shellac Research Bureau. This scheme has developed from the work of the Special Lac Officer in London and three Indian research chemists appointed by the Committee are now working in industrial research laboratories at Teddington and Rugby by arrangement with the Paint and Varnish Trades Research Association and the Electrical Industries Research Association, respectively. Here technical and scientific problems bearing directly on the greater use of lac in industry are taken up in consultation with those industries.

Lac as a commodity appears doomed to suffer unduly from the attentions of the speculator. Since the above work was published, a 'corner' has collapsed and lac again seems to be approaching the slump prices of 1932-33. But research such as that described by broadening the basis both of demand and production should, at any rate, spell greater prosperity for the lac-grower and the shellac manufacturers. [EDITOR].

The Progress of Rural Welfare in India, 1934. By C. F. STRICKLAND, C.I.E. *Oxford University Press. (Price in India eight annas).*

This handy little brochure issued under the auspices of the Indian Village Welfare Association is an admirable sequel to the same author's Review of Rural Welfare Activities published by the Oxford University Press in 1932. The Association in Mr. Strickland's own words, "aims at bringing together those who are familiar with the condition of the rural population in India and are anxious to improve it by constructive measures." The Association limits itself almost entirely to publicity and propaganda and has published pamphlets on rural vernacular, broadcasting and on child marriage. In addition to holding meetings and inviting addresses on special subjects of rural interest, it has successfully organised three Easter schools for persons engaged in or proposing any rural work in India. The author emphasises the importance of the criteria of *effective* rural construction laid down in his 1932 Review and these will bear repetition. They are :—

(1) *Permanence.*—Is the work dependent on the presence of an individual who may be removed, or of an organization which may, through a change of policy, cease to take interest in it ? In the event of such removal or change, will the work collapse, or will it be continued by local residents for whose benefit it is intended ?

(2) *Co-ordination.*—Is each official department or unofficial organization operating independently along a single line, or are all forces, official and unofficial, being co-ordinated in an attack upon the rural problem on a broad front with the maximum of co-operation ?

(3) *Personnel.*—Are the men or women who are engaged in the work trained and qualified for their task, whether technical or social, or are they amateurs who learn, perhaps painfully, at the expense of those with whom they deal ?

(4) *Cost.*—Are the results proportionate (in importance and in permanence) to the money spent ? Is the scheme one which ought to become, self-supporting, and does it appear likely to do so ?

In justifying the second and third of these, he alludes to the danger of official departments connected with rural uplift falling into the snare of over-independent working and shows that a non-official body may perform a valuable service by bringing together the various officials for co-ordinated effort in a selected village or area and what is perhaps equally important, by recalling their instructions and repeating their demonstrations after their departure. Then follows a summary of the propaganda work carried out in the various provinces, largely by the provincial Governments, it may be observed, which will be of considerable use to all rural uplift workers. The last few pages of the book are occupied with some general observations which merit careful thought. Here Mr. Strickland explains the importance of broad planning. He also points out that there are three main agencies for rural uplift, *viz.*, the departments of Government concerned with rural life and welfare; village rural reconstruction centres and 'extensive' societies like the Red Cross; the Servants of India; the Bhil Seva Mandal and many others which operate throughout the country or over large areas. Clearly, all three of these should be united in consultation though retaining full independence of action. And very rightly, he emphasises the need for building from below and the important part which Co-operative Betterliving Societies should play as a permanent living force for rural betterment. Mr. Strickland writes with intimate knowledge and practical experience as well as enthusiasm and his book should be of help to many. [EDITOR].

The Empire Journal of Experimental Agriculture, published quarterly by MR. HUMPHREY MILFORD, *Oxford University Press, London, E. C. 4. Annual subscription 20 s., post free.*

With the January number, the Empire Journal of Experimental Agriculture commences its third year and third volume and readers will note that there has been a slight change in editorial policy as the latest number contains more in the way of authoritative summaries of the recent position of agricultural research. To many readers this change will be welcome. An important group of five papers on "the Inheritance of Productivity in Farm Livestock" is of particular interest; these were read to section D (Zoology) of the British Association at its Aberdeen meeting in September 1934. A paper on 'the Effect of Shade on American Cotton' by R. L. Knight describes experiments carried out at Shambar in the Northern

Sudan being designed as a preliminary investigation to determine by means of artificial shades the effect of continued clouds on American cotton. The experiment does much to throw light on the need for abundant sunshine for rain grown cotton and the effect of excessive shade and will be of interest to any cotton experimenters in India.

The previous October number of the same journal contains an article by Dr. L. C. Coleman on 'the Coffee planting Industry of South India', which his many friends in this country will recognise as an authoritative contribution. Dr. Coleman was largely responsible for the establishment in 1925 of the Coffee Research Station at Balehonnoor in the Mysore State. Another article which should be of great interest to Indian readers is 'A Review of Recent Methods and Results in Sugarcane-breeding' by Glendon Hill of the Sugarcane Research Station, Mauritius. Mention should be made of two papers in soil science *viz* :—one by N. Craig and P. Halais on 'the Influence of Maturity and Rainfall on the Properties of Lateritic Soils in Mauritius' and Morley Davies and Owen's paper on the 'Soil Survey of North Shropshire' which indicates the lines on which modern soil surveys are now conducted. The paper by Coombs on 'the Border Effect in Plot Experiments' will appeal to the many agricultural experimenters in India who are concerned with the technique of field experiments. (EDITOR.)

NEW BOOKS

On Agriculture and Allied Subjects

Embryology and Genetics. By Prof. T. H. Morgan, pp. viii + 258. New York. Columbia University Press: London: Oxford University Press, 1934. 15*s*. net.

Diseases of the Banana and of the Manilla Hemp Plant. By C. W. Wardlaw, Pathologist for Banana Research, Trinidad: Imperial College of Tropical Agriculture, Trinidad, 1934. 30*s*. net.

Edible and Poisonous Fungi. Fourth Edition (Bulletin No. 23 of the Ministry of Agriculture and Fisheries), pp. v + 25 + 24 plates. 3*s*. 6*d*. net.

Experiments on Inbreeding of Poultry (Bulletin No. 83 of the Ministry of Agriculture and Fisheries), pp. v + 59 + 5 plates. 1*s*. net.

The Brown Rot Diseases of Fruit Trees (Bulletin No. 88 of the Ministry of Agriculture and Fisheries), pp. v + 50 + 28 plates. 1*s*. 6*d*. net.

Farm Buildings. By Edwin Gunn, A.R.I.B.A., Ed. by H. C. Long. ("The Birkins", Orchard Road, Hook, Surbiton, 1935). Price 5*s* net.

Pioneers in Power Farming. By C. S. Orwin. Progress in English Farming Systems VIII. Illustrated. PP. 26. (Oxford: Agricultural Economics Research Institute, 1934.) Price 1*s*·6*d*.

Black's Veterinary Dictionary. Edited by Wm. C. Miller, M.R.C.V.S., F.R.S.E. 2nd Edition, revised and enlarged, pp. 1,140, 8 plates and 326 figures. A. & C. Black, Ltd., London. Price 21*s*. net.

List of Agricultural Publications in India from 1st August 1934 to 31st January 1935.

No.	Title	Author	Where published
	GENERAL AGRICULTURE		
1	*Agriculture and Livestock in India*, Vol. IV, Parts 5 and 6 and Vol. V, part 1. Annual subscription Rs. 6 or 9*s*. 9*d*. (A bi-monthly Journal of Agriculture and Animal Husbandry for the general reader interested in agriculture or livestock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
2	*The Madras Agricultural Journal.* - (Monthly). Annual subscription Rs. 4.	T. V. Ramakrishna Ayyar (Editor). Published by the M. A. S. Union, Agricultural and Research Institute, Coimbatore.	The Scholar Press, Palghat.
3	*The Journal of the Trichinopoly District Agricultural Association.* (English and Tamil). Quarterly. Annual subscription Re. 1-8-0 for non-members, free for members.	Issued by the Trichinopoly District Agricultural Association, Teppakulam post.	Muruga Vilas, Janann Koola Press, Trichinopoly.
4	The Gardening Review (Monthly) Annual subscription Rs. 3.	C. V. Krishnaswami Aiyar (Editor).	The Pearless Press, Madras.
5	*Journal of the Mysore Agricultural and Experimental Union.*- (English.) Quarterly Price As. 12 per copy.	B. Narasimha Iyengar (Chief Editor).	Bangalore Press, Bangalore.
6	*Journal of the Mysore Agricultural and Experimental Union.*—(Kannada) Monthly. Price As. 4 per copy.	N. Venkatasubbaiya .	Ditto.
7	*Poona Agricultural College Magazine.* (Quarterly). Annual subscription Rs. 2-8-0.	V. G. Deshpande and S. M. Rao (Editors).	Arya Bhushan Press, Poona City.
8	*Shetki Shetkhari* (Marathi, Monthly). Annual subscription Re. 1-3-0.	Narhar Gangadhar Apte.	Ditto.
9	The *Planters Journal and Agriculturist* (Fortnightly). Annual subscription Rs. 10 or 16*s*.	Theo. H. Thorne (Editor).	The Ganges Printing Co. Ltd., Howrah.
10	*Krishi-Sampad* (Bengali, Monthly). Annual subscription Rs. 3.	N. K. Ghosh . .	Krishi Sampada Press, Dacca.

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GENERAL AGRICULTURE—*contd.*

No.	Title	Author	Where published
11	*Mufidul Mazarain* (Urdu) . .	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, U. P., Allahabad.
12	*Kisan Upkarak* (Hindi) . . .	Ditto . .	Ditto.
13	*The Allahabad Farmer* (Bi-monthly). Annual subscription in India Rs. 2.	W. J. Hansen (Editor). Published by the Agricultural Institute, Allahabad.	The Mission Press, Allahabad.
14	*Seasonal Notes.* (Price, As. 4 per copy.)	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
15	*The Nagpur Agricultural College Magazine* (Quarterly). Annual subscription Rs. 3.	Published by P. D. Nair, Agricultural College, Nagpur.	The Central India Printing Works, Nagpur.
16	Annual Report of the Imperial Council of Agricultural Research for the year 1933-34.	Issued by the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
17	Mechanical Cultivation in India:—A history of the large scale experiments carried out by Burma Shell Oil Storage and Distributing Company of India, Ltd. Scientific Monograph No. 9 of the Imperial Council of Agricultural Research Price Rs. 3-14 or 6*s.* 6*d.*	C. P. G. Wade . .	Ditto.
18	Report on Coconut Enquiry in India. Issued by the Imperial Council of Agricultural Research. Price Rs. 3-8-0 or 6*s.*	J. S. Patel . .	Manager of Publications, Delhi.
19	Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist and Sugarcane Expert) for 1932-33. Price Rs. 4-12-0 or 8*s.*	Director, Imperial Institute of Agricultural Research, Civil Lines, Delhi.	Ditto.
20	Report on the Operations of the Department of Agriculture, Madras Presidency for 1933-34.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
21	Villagers' Calendar for 1935. English	Issued by the Department of Agriculture, Madras.	Ditto.
22	Villagers' Calendar for 1934-35. (July 1934 to June 1935). Malayalam.	Ditto	Ditto.

GENERAL AGRICULTURE—*contd.*

No.	Title	Author	Where published
23	The Improvement of the Coconut under dry Cultivation, Malayalam and Kanarese. Leaflet No. 59 of the Department of Agriculture, Madras.	K. W. Chakrapani Marar.	Government Press, Madras.
24	A bund forming implement. Leaflet No. 61 of the Department of Agriculture, Madras.	N. G. Charley . .	Ditto.
25	Coriander—How to improve its quality for marketing. English, Tamil, Telugu, Kanarese and Malayalam. Leaflet No. 62 of the Department of Agriculture, Madras.	P. V. Ramiah . .	Ditto.
26	A simple and cheap process for the conservation of Farmyard Manure. Telugu. Notes of the Department of Agriculture, Madras.	T. Budhavidheya Rao.	Ditto.
27	Malayalam Sayings and Proverb on Agriculture. Malayalam. Bulletin of the Department of Agriculture, Madras.	K. T. Alwa and K. Unnikrishna Menon.	Ditto.
28	Picking and marketing of cambodia cotton in Salem District. English and Tamil. Leaflet No. 62 of the Department of Agriculture, Madras.	K. Raghavachari .	Ditto.
29	*Tariqa Kasht Jarham Dhan.* (Urdu and Hindi). Leaflet No. 8 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, U. P., Allahabad.
30	*Mausam-i-garma ki Jotai, Gehun aur Rabi ke dusri faslon ke waste.* (Urdu and Hindi). Leaflet No. 9 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
31	Agricultural Implements, Part I. (English and Urdu). Leaflet No. 10 of the Department of Agriculture, U. P.	Ditto . .	Ditto.
32	Agricultural Implements, Part II. (English). Leaflet No. 11 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.

GENERAL AGRICULTURE—*contd.*

No.	Title	Author	Where published
33	Manures. (English and Hindi). Leaflet No. 12 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Province.	Government Printing and Stationery, U. P., Allahabad.
34	*Rabi ki fasl ki katai ke babat chand baten* (Hindi). Leaflet No. 16 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
35	*Tariqa Kasht Kapas No. 520.* Leaflet No. 17 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
36	C. 591. A new high quality wheat. Leaflet No. 118 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
37	Sun-heat treatment of cotton seed as a prevention against pink bollworm. Leaflet No. 122 of the Department of Agriculture, Punjab.	Ditto . .	Ditto.
38	Annual Report of the Department of Agriculture, Bihar and Orissa. 1933-34.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.
39	Annual Report on Experimental Farms in Bihar and Orissa, 1933-34.	Ditto . .	Ditto.
40	A Note on Agricultural calendar for Orissa and some systems of multiple cropping under Orissa conditions.	Ditto .	Ditto.
41	Report on the working of the Department of Agriculture of the Central Provinces for the year ending the 31st March 1934. Price Re. 1-8-0.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
42	Annual Report on Experimental Farms, Nagpur, Akola, Powarkhera, Adhartal, Chhindwara, Tharsa and Raipur, for the year ending the 31st March 1934. Price Re. 1-8-0.	Ditto .	Ditto
43	Report on Demonstration work carried out in the Southern Circle, C.P., together with Reports on the Seed and Demonstration and Cattle Breeding Farms of the Circle for the year ending the 31st March 1934. Price, Re. 1-8-0.	Ditto .	Ditto.
44	Report on Demonstration work carried out in the Northern Circle, C. P., together with Reports on the Seed and Demonstration and Cattle Breeding Farms of the Circle for the year ending the 31st March 1934. Price, Re. 1-8-0.	Ditto .	Ditto.

GENERAL AGRICULTURE—*concld.*

No.	Title	Authors	Where published
45	Report on Demonstration work carried out in the Western Circle, C. P., together with Reports on the Seed and Demonstration and Cattle Breeding Farms of the Circle for the year ending the 31st March 1934. Price, Re. 1-8-0.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
46	Report on Demonstration work carried out in the Eastern Circle, C. P., together with Reports on the Seed and Demonstration and Cattle Breeding Farms of the Circle for the year ending the 31st March 1934. Price, Re. 1-8-0.	Ditto .	Ditto.
47	Report on the Agricultural College, Nagpur for the year ending 31st March 1934.	Ditto . .	Ditto.
48	Report on the Agricultural Engineer's Section, Agricultural College, Nagpur for the year ending 31st March 1934.	Ditto .	Ditto.
49	A Scheme for the extension of long staple cotton in the Central Provinces and Berar. (Hindi and Marathi). Leaflet of the Department of Agriculture, Central Provinces.	Ditto .	Ditto.
50	Annual Report of the Department of Agriculture, Assam, for the year 1933-34.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
51	Progress Report of the Institute of Plant Industry, Indore, Central India for the year ending 30th June 1934.	Issued by the Director, Institute of Plant Industry, Indore.	Examiner Press, Bombay.
52	Cotton cultivation in Gang Canal Colony (Urdu). Leaflet No. 9 of the Institute of Plant Industry, Indore.	Ditto .	Ditto.
53	Annual Report of the Indian Central Cotton Committee for the year ending 31st August 1934. Price Rs. 2.	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
54	Report on the Administration of the Agricultural Department in the Cochin State for the year 1108 (1932-33).	Issued by the Superintendent of Agriculture, Trichur.	Cochin Government Press, Ernaculam.
55	Selection of Paddy Seeds. Malayalam. Leaflet of the Department of Agriculture, Cochin.	Ditto .	Ditto.
56	Annual Report of the Coffee Scientific Officer, 1933-34. Mysore Coffee Experimental Station Bull. No. 12.	W. W. Mayne . .	Government Press, Bangalore.

No.	Title	Authors	Where published
	AGRICULTURAL STATISTICS		
57	Season and Crop Report of Bengal for the year 1933-34. Price, As. 8.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipur, Bengal.
58	Season and Crop Report of the United Provinces of Agra and Oudh for the year 1933-34 (1341 Fasli).	Issued by the Department of Land Records, United Provinces.	Superintendent, Printing and Stationery, U. P., Allahabad.
59	Report on the Season and Crops of the Punjab for the agricultural year ending 30th June 1934. Price, Rs. 3-4-0.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
60	Agricultural Statistics, 1933-34	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.
61	Season and Crop Report of Bihar and Orissa for the year 1933-34. Price, Rs. 2-4-0.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Printing, Bihar and Orissa, Patna.
62	Season and Crop Report of the Central Provinces and Berar for the year ending the 31st May 1934. Price, Re. 1-8-0.	Issued by the Director of Land Records, Central Provinces and Berar.	Government Printing, Central Provinces, Nagpur.
	SUGAR RESEARCH		
63	Some practical suggestions to cane growers (Telugu).	S. Sitaram Patrudu	Government Press, Madras.
64	Manufacture of white sugar and *gur* by the open-pan process. Bulletin No. 175 of 1934 of the Department of Agriculture, Bombay. Price, As. 3.	V. V. Gadgil	Government Central Press, Bombay.
65	*Ikh ki bowai jaldi karo pichhar jane se nuqsan hai.* Urdu and Hindi. Leaflet No. 6 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, U. P., Allahabad.
66	*Ganna perna aur shakar banana.* Urdu and Hindi. Leaflet No. 7 of the Department of Agriculture, United Provinces.	Ditto	Ditto.
67	The Improved Method of *Gur* Manufacture. Leaflet No. 5 of the Institute of Plant Industry, Indore.	Issued by the Director, Institute of Plant Industry, Indore.	Examiner Press, Bombay.

COTTON TECHNOLOGY

No.	Title	Authors	Where published
68	Spinning Test Report (No. 498) on samples of Karunganni Cotton, 1933-34. Price, As. 4	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
69	Spinning Test Report (No. 503) on samples of Navsari Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
70	Spinning Test Report (No. 504) on samples of Cambodia Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
71	Spinning Test Report (No. 509) on samples of Kadi-viramgam Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
72	Spinning Test Report (No. 510) on samples of Tinnevelly Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
73	Spinning Test Report (No. 511) on samples of Bagalkot Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
74	Spinning Test Report (No. 514) on samples of A. R. Kampala, A. R. Busoga, and A. R. Jinja Cottons, 1933-34. Price, As. 4.	Ditto .	Ditto.
75	Spinning Test Report (No. 515) on samples of Bijapur Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
76	Spinning Test Report (No. 516) on samples of Upland Cotton, 1933-34. Price, As. 4.	Ditto .	Ditto.
77	Spinning Test Report (No. 517) on samples of Karunganni Cotton, 1933-34. Price, As. 4.	Indian Central Cotton Committee, Bombay.	Ditto.
78	Technological Report on Verum 262 (Nagpur) 1934-35. Price, As. 4.	Ditto .	Ditto.
79	Technological Report on Verum 262 (Akola) 1934-35. Price, As. 4.	Ditto .	Ditto.
80	Technological Report on Verum 262 (Akola) 1934-35. Price, As. 4.	Ditto .	Ditto.
81	Technological Report on Umri Bani, 1934-35. Price, As. 4.	Ditto .	Ditto.
82	Technological Report on Punjab-American 289F, 1934-35. Price, As. 4.	Ditto .	Ditto.

No.	Title	Author	Where published
	COTTON TECHNOLOGY—*contd.*		
83	Technological Bulletin, Series A, No. 26. Technological Reports on Standard Indian Cottons, 1934. Price, Re. 1-8-0.	Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
84	Statistical Leaflet No. 2 of 1933-34. Stocks of Indian Raw Cotton held in India by the Mills and the Trade on 31st August 1934. Price, 1 anna.	Ditto .	Ditto.
85	Statistical Leaflet No. 3 of 1933-34. Receipts at Mills in India of Raw cotton classified by varieties, 1933-34 Season. Price, 1 anna.	Ditto .	Ditto.
86	Statistical Leaflet No. 4 of 1933-34. Exports by Sea of Indian Raw Cotton classified by varieties, 1933-34 Season. Price, 1 anna.	Ditto .	Ditto.
	FRUITS		
87	Citrus Cultivation. Urdu and Hindi translations of Bulletin No. 6, Fruit Series, of the Department of Agriculture, United Provinces.	R. G. Allan .	Government Printing and Stationery, U. P., Allahabad.
88	The Guava. Bulletin No. 8, Fruit Series of the Department of Agriculture, United Provinces.	W. S. Smith . .	Ditto.
89	Fruit Culture in the Hills. Bulletin No. 10, Fruit Series of the Department of Agriculture, United Provinces.	J. G. Burns .	Ditto.
	Sundry papers on Fruit Development, Fruit Growers' Organization and the necessity of improving the basis of marketing. Bulletin No. 11, Fruit Series of the Department of Agriculture, United Provinces.	R. G. Allan . .	Ditto.
	Lemon Squash and Lemon Juice. Leaflet No. 124 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
[illegible]2	Lemon Beverages. Leaflet No. 5 of 1934 of the Department of Agriculture, Bihar and Orissa.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.

No.	Title	Author	Where published
	LAC		
93	Annual Report of the Indian Lac Research Institute, Namkum, Ranchi, Bihar and Orissa, for the year 1933-34.	Issued by the Indian Lac Research Institute, Namkum.	The Star Printing Works, Calcutta.
94	Advice on the more profitable use of the *Kusum* tree (*Schleichera trijuga*) as a lac host. (English, Hindi and Oriya).	Ditto	Ditto.
95	A further means of dispersing 'Polymerised' Shellac. Indian Lac Research Institute Research Note No. 17.	M. Venugopalan and R. W. Aldis.	Ditto.
96	Some effects of Hydrochloric acid on Shellac Varnish. Indian Lac Research Institute Research Note No. 18.	R. W. Aldis .	Ditto.
97	The Heat Curing of Shellac, Part II. Depolymerisation. Indian Lac Research Institute, Bulletin No. 19.	M. Rangaswami and R. W. Aldis.	Ditto.
98	Further Notes on the use of *Schleichera trijuga* (*Kusum*) in Lac Cultivation. Indian Lac Research Institute, Bulletin No. 20.	Dorothy Norris . .	Ditto.
99	A Check List of the Chalcidoidea bred at Namkum from the lac insect *Laccifer lacca* with some notes as regards their function, economic importance and control. Indian Lac Research Institute, Bulletin No. 21.	P. M. Glover . .	Ditto.
100	The Biology of *Holcocera pulberca* Meyr. (Blastobasidae), its predators, parasites and control.	M. P. Misra and S. N. Gupta.	Ditto.
	AGRICULTURAL SCIENCE		
	General		
101	*The Indian Journal of Agricultural Science*, Volume IV, parts 4, 5 and 6. Annual subscription Rs. 15 or 24*s*. (Original scientific work in the various branches of science applied to agriculture, formerly published in the Memoirs of the Imperial Department of Agriculture in India is now published in the Indian Journal of Agricultural Science.)	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.

No.	Title	Author	Where published
	BOTANY		
102	Report of the Experimental work of the Botanical Section, Bihar and Orissa, for the year ending 31st March 1934.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.
	Scientific Reports of the Imperial Institute of Agricultural Research, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist and Sugarcane Expert) for 1932-33. Price Rs. 4-12-0 or 8s.	Director, Imperial Institute of Agricultural Research, Civil Lines, Delhi.	Manager of Publications, Delhi.
103	Report on the Botanical Research, Agricultural College, Nagpur for the year ending 31st March 1934.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
	CHEMISTRY		
104	Experiments in Manuring Crops in the Bombay Presidency, 1896—1931. Price Rs. 2-9-0.	D. L. Sahasrabuddhe	Government Central Press, Bombay.
105	Report on the Chemical Research, Agricultural College, Nagpur for the year ending 31st March 1934.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
106	Studies on the Pectic substances in Tea: U. P. A. S. I. Tea Scientific Department, Bulletin No. 6.	W. S. Shaw . .	The Madras Publishing House, Madras.
107	The Nitrogen Distribution in Tea. U. P. A. S. I. Tea Scientific Department, Bulletin No. 7.	Ditto . . .	Ditto.
108	A Note on the Effect of Sodium Chloride on the Germination of Paddy Seeds.	N. K. Balaram Kurup	Government Press, Trivandrum.
109	Irwin Canal Soil Survey Report. Series No. 1. Introductory and General Part. Price As. 8.	B. Narasimha Iyengar	Superintendent, Government Press, Bangalore.
	PLANT DISEASES		
110	Koleroga or *Mahali* disease of arecanuts. Leaflet No. 53 of the Department of Agriculture, Madras (Tamil, Telugu, Kanarese and Malayalam).	S. Sundararamier .	Government Press, Madras.
111	Some common Fungoid Disease of crops and their preventive measure (Review) English and Bengali.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipur.
112	Report on the Mycological Research, Agricultural College, Nagpur for the year ending 31st March 1934.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.

No.	Title	Author	Where published

ENTOMOLOGY

No.	Title	Author	Where published
113	Host Plant Index of Indo-Ceylonese Coccidae. Misc. Bull. No. 4 of the Imperial Council of Agricultural Research. Price Rs. 1-10 or 2*s.* 9*d.*	S. Ramachandran and T. V. Ramakrishna Ayyar.	Manager of Publications, Delhi.
114	Some more Injurious insect Pests of Crops. English and Bengali, Bulletin No. 1 of 1934 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipur.
115	The New Pyralid Borer of Sugarcane. Leaflet No. 116 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab,	Government Printing, Punjab, Lahore.
116	A Note on Pests and Diseases of *Rabi* Crops. Leaflet No. 119 of the Department of Agriculture, Punjab.	Ditto .	Ditto.
117	A Note on Pests and Diseases of *Kharif* Crops. Leaflet No. 120 of the Department of Agriculture, Punjab.	Ditto .	Ditto.
118	A Note on Pests of Fruit Trees and Vegetables. Leaflet No. 121 of the Department of Agriculture, Punjab.	Ditto .	Ditto.
119	A New Insect Pest of Rice in the Sheikhupura and Gujranwala Districts. Leaflet No. 123 of the Department of Agriculture, Punjab.	Ditto .	Ditto.
120	Report on the Entomological Research, Agricultural College, Nagpur for the year ending 31st March 1934.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
121	Indarbela—a Serious Pest of Orange, Guava and Peach and its control. (English, Hindi and Marathi). Leaflet of the Department of Agriculture, Central Provinces.	Issued by the Department of Agriculture, Central Provinces.	Ditto.
122	Bee-keeping. Bulletin No. 4 of the Department of Agriculture, Assam, 1934.	Issued by the Department of Agriculture, Assam.	Government Press, Assam, Shillong.
123	Pamphlet on the Pink Bollworm Pest of Cotton and How to Control it (English, Hindi and Urdu).	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
124	Sugarcane Borers and their Control in the Mysore State. Circular No. 53 of the Department of Agriculture, Mysore.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.

VETERINARY SCIENCE AND ANIMAL HUSBANDRY

No.	Title	Author	Where published
125	*Agriculture and Livestock in India*, Vol. IV, parts 5 and 6 and Vol. V, part 6. Annual subscription Rs. 6 or 9*s*. 9*d*. (A bi-monthly Journal of Agriculture and Animal Husbandry for the general reader interested in Agriculture or Livestock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
126	*The Indian Journal of Veterinary Science and Animal Husbandry*, Vol. IV, parts 3 and 4. Annual subscription Rs. 6 or 9*s*. 9*d*. (A Journal for the publication of Scientific matter relating to the health, nutrition and breeding of livestock).	Ditto .	Ditto.
127	The Indian Veterinary Journal. (The Journal of the All-India Veterinary Association. Quarterly). Annual subscription Rs. 4 or 6*s*. 4*d*. for members and students, Rs. 8 or 10*s*. for others.	P. Srinivas Rao .	Peoples Printing and Publishing House, Ltd., Madras.
128	*The United Provinces Veterinary Magazine* (English and Urdu monthly). Issued free to members of the United Provinces Veterinary Association.	R. K. Nath . .	Standard Printing Works, Lucknow.
129	*The Punjab Veterinary Journal* (Monthly). Annual subscription Rs. 8.	Issued by the Punjab Veterinary Association	Feroz Printing Works, Lahore.
130	*Central Provinces Veterinary Journal* (Quarterly).	Issued by the Central Provinces Veterinary Association, Nagpur.	Government Printing, Nagpur.
131	Proceedings of the First Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry held at New Delhi from the 20th to 23rd February 1933, with Appendices. Price Rs. 5-14 or 9*s*. 6*d*.	Issued by the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
132	Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1934. Price Re. 1-12 or 3*s*.	Director, Imperial Institute of Veterinary Research, Muktesar.	Manager of Publications, Delhi.
133	Annual Administration Report of the Civil Veterinary Department, Madras, for the year 1933-34.	Issued by the Director, Veterinary Services, Madras.	Government Press, Madras.

VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*

No.	Title	Authors	Where published
134	Report of the Special Rinderpest Officer, Madras Presidency. Price Re. 1-6-0.	C. Suryanarayana-murthi.	Government Press, Madras.
135	Some Advantages of Poultry Keeping. Malayalam. Leaflet No. 54 of the Department of Agriculture, Madras.	R. W. Littlewood .	Ditto.
136	Natural Incubation. Malayalam. Leaflet No. 55 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
137	Brooding and Rearing of Chicks, Malayalam. Leaflet No. 56 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
138	Lucerne. (Tamil, Telugu and Kanarese). Leaflet No. 58 of the Department of Agriculture, Madras.	Ditto . .	Ditto.
139	Housing of Poultry. (Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 57 of the Department of Agriculture, Madras.	R. W. Littlewood and H. Narahari Rao.	Ditto.
140	Annual Report of the Civil Veterinary Department, United Provinces, for 1933-34.	Issued by the Director of Veterinary Services, United Provinces.	Government Printing and Stationery, U. P., Allahabad.
141	Green Fodder. (English and Hindi). Leaflet No. 13 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Govornent Printing and Stationery, U. P., Allahabad.
142	Cultivation of Lucerne. (English, Urdu and Hindi). Leaflet No. 14 of the Department of Agriculture, United Provinces.	Ditto .	Ditto.
143	List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1934-35.	Issued by the Director, Veterinary Services, Punjab.	Government Printing, Punjab, Lahore.
144	Report on the Veterinary Department, Burma for the year ending 31st March 1934.	Issued by the Director, Veterinary Services, Burma.	Government Printing, Burma, Rangoon.
145	Instruction for Collection of External Parasites from Animals in Burma. Leaflet No. 1 of 1935 of the Veterinary Department, Burma.	Ditto	Superintendent, Government Printing and Stationery, Burma.
146	Instructions for the use of 'Naganol' in the Prophylactic and Curative Treatment of Surra in Horses and Mules. Leaflet No. 2 of 1935 of the Veterinary Department, Burma.	Ditto .	Ditto.

VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*concld.*

No.	Title	Authors	Where published
147	Annual Report of the Civil Veterinary Department, Bihar and Orissa for the year 1933-34.	Issued by the Director, Veterinary Services, Bihar and Orissa.	Superintendent, Government Printing Bihar and Orissa Patna.
148	Annual Report of the Civil Veterinary Department, Central Provinces and Berar for the year ending 31st March 1934.	Issued by the Director, Veterinary Services, Central Provinces.	Government Printing, Central Provinces, Nagpur.
149	Report on the Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending 31st March 1934.	Issued by the Department of Agriculture, Central Provinces.	Ditto.
150	Revised Rules for the grant of Premium to certified and selected Bulls for Breeding purposes under the premium bull scheme of the Agriculture Department. (Hindi and Marathi). Leaflet of the Department of Agriculture, Central Provinces.	Ditto .	Ditto.
151	Annual Report of the Civil Veterinary Department, Assam, for 1933-34.	Issued by the Superintendent, Civil Veterinary Department, Assam.	Assam Government Press, Shillong.
152	The Making and Use of Silage in Assam. Bull. No. 3 of 1934 of the Department of Agriculture, Assam.	Issued by the Department of Agriculture, Assam.	Assam Government Press, Shillong.
153	Dairying and Dairy Farming, Bull. No. 5 of 1935 of the Department of Agriculture, Assam.	Ditto .	Ditto.
154	Annual Administration Report of the Civil Veterinary Department, Ajmer-Merwara (British Rajputana) for the year 1933-34.	Issued by the Superintendent, Civil Veterinary Department, Sind and Rajputana.	Manager of Publications, Delhi.
155	Lucerne cultivation. Leaflet No. 7 of the Institute of Plant Industry, Indore.	Issued by the Director, Institute of Plant Industry, Indore.	Examiner Press, Bombay.
156	The Poultry Survey Report of H. E. H. the Nizam's Dominions. Bulletin No. 7 of the Agricultural Department, Hyderabad-Deccan.	Nizamuddeen Hyder .	Government Central Press, Hyderabad, Deccan.

ERRATA

Agriculture and Livestock in India, Vol. V, Part 1.

Page ii, page number against the first item, *for* '48' *read* '47'.
Page 10, Table VIII, column 3, last row, *for* '86' *read* '8·6'.
Page 51, first line, *for* 'Jaffrabari' *read* 'Jaffrabadi'.
Page 92, line 2, *for* 'inerease' *read* 'increase'.
Page 92, line 5, *for* 'Eassays' *read* 'Essays'.
Page 101, line 21, *for* 'Tadstools' *read* 'Toadstools'.

GIPD—M679 IC of AR—25-6-35—1,000.

Dr. Leslie Coleman, C. I. E., M. A., Ph. D.

ORIGINAL ARTICLES

Dr. LESLIE COLEMAN, C. I. E., M. A., Ph.D.: AN APPRECIATION

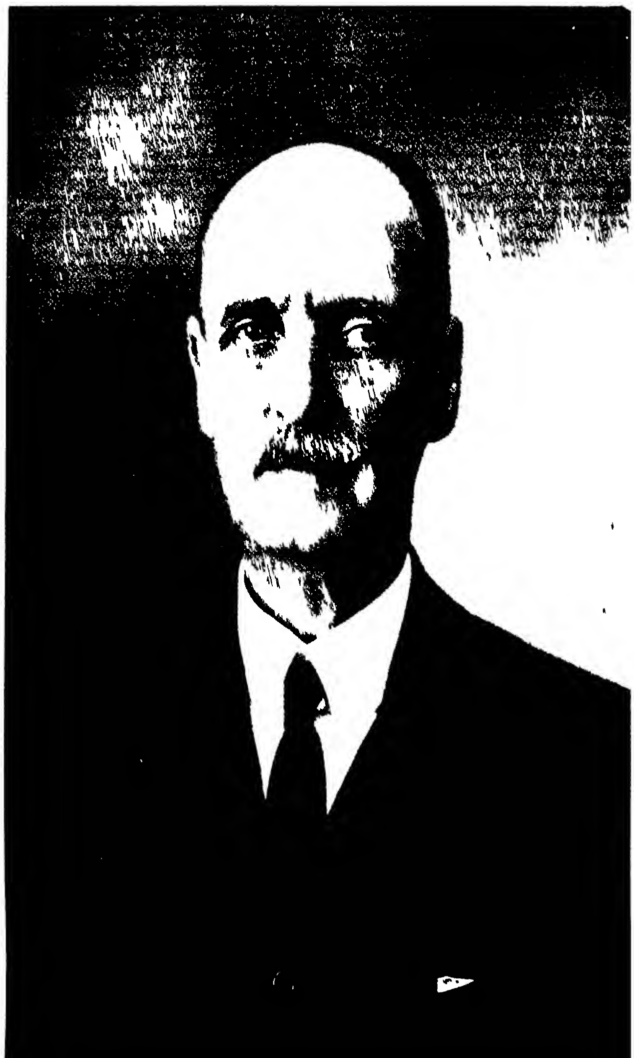
Dr. Coleman was born near Toronto on the 16th of June 1878 and was educated at the University of Toronto, where he obtained the degree of M. A. in 1905, winning the Governor-General's Gold Medal. Subsequently he studied at Göttingen and took the degree of Ph.D. in 1907, having specialised in plant pathology. He joined the service of the Mysore State in 1908 and until 1913 held the post of the State Entomologist and Mycologist in Mysore. On the retirement of Dr. Lehman, Agricultural Chemist to the Mysore State, in 1910, he took charge of the latter's duties also. When the Mysore Agricultural Department was established in 1913, Dr. Coleman was appointed as its first Director, a post which he held till his retirement in 1934, save for a temporary period of absence during the war and various periods of leave.

As a scientific officer, Dr. Coleman will be remembered in India for his work on the Koleroga disease of arecanut which resulted in control measures which are now in practical operation, for his work on coffee diseases and for his work on the *jola* grass hopper. He was also a pioneer in the investigation of the 'spike' disease of sandal, and he established its infectious character by grafting experiments and at a comparatively early date suggested that it was probably caused by a filter-passing virus. The Balehonnur Coffee Research Station, which is maintained jointly by the United Planters' Association of South India and the Mysore Department of Agriculture, was largely due to his enterprise and foresight.

To few agricultural officers is it given to build up an agricultural department from the foundations and to guide its activities for over twenty years. The success which Dr. Coleman achieved needs no emphasis and he has left behind him an active organisation. In the Mysore State itself, he is perhaps best remembered by the attention he gave to the needs of the ryot, his close contact with him and intimate knowledge of his affairs. It was no unusual thing to find him in a peasant's cottage sharing with him his *ragi* gruel. He was looked on as a personal friend by cultivators throughout the State and his name will long be remembered in many a humble rural home.

Dr. Coleman started his Indian career at the same time as many of the senior members of the Indian Agricultural Service and was a regular and valued member of the Board of Agriculture in India. Not only was he personally popular, but he established a reputation for his department by the high standard of work on which he insisted. On the Board of Agriculture, the Indian Central Cotton Committee and latterly the Advisory Board of the Imperial Council of Agricultural Research, his scientific knowledge and sound judgment were recognised to be an asset. Both plant-breeding and improvement of livestock came in for his active attention and he placed the plant-breeding work of the department on a sound footing and also re-organised the cattle and sheep-breeding. He was also responsible for the re-organisation of the Sericultural and Veterinary Departments of the Mysore State and for the establishment of its Serum Institute. During the last three years of his service, he was actively engaged in the establishment of the Mysore Sugar Factory at Mandya and with the general development of sugarcane production in the Irwin Canal area.

The recognition of Dr. Coleman's services to Indian Agriculture by the award of the C. I. E. in 1930 gave pleasure to a wide circle of friends and colleagues. Though he reached the normal retiring age in 1933, it had confidently been expected that he would serve the Mysore State and India for several years more. But this was not to be, for a serious illness followed by continued ill-health led to his retirement in 1934. His many friends in India trust that he will enjoy many years of happy retirement in the land of his birth and contribute still further to the advancement of agricultural science. [T. V.]



Dr F J Warth, D Sc

Dr. FREDRIC JOHN WARTH, B.Sc. (Lond.), D.Sc. (Birmingham): AN APPRECIATION

By the retirement of Dr. F. J. Warth, Physiological Chemist, Imperial Institute of Animal Husbandry and Dairying, Bangalore, from Government service on 23rd March 1935, the Indian Agricultural Service has lost one of its most experienced and capable workers.

Dr. Warth was born on 23rd March 1879 and received his education first at Merchiston Castle School, Edinburgh, and then in the Birmingham University. He graduated in science in 1901, with honours in chemistry and became a chemical research scholar in the University where he displayed considerable zeal in the prosecution of an investigation—a thesis which secured for him the degree of of M. Sc.

Before coming out to India in 1906 as Agricultural Chemist to the Government of Burma, Dr. Warth was a Science Master for 3 years at Burford Grammar School where he gained valuable experience in laboratory work and in teaching chemistry. He organised and developed the Chemical Section of the Department of Agriculture, Burma, and carried out important investigations in connection with the manurial requirements of soils of the province.

When in connection with a scheme for the development of cattle-breeding in India a new section was created in 1921 for dealing with problems connected with animal nutrition, Dr. Warth was selected as its head. The work of this section first began at Pusa and was then transferred in 1923 to Bangalore with the transfer of the Military Dairy there to the Imperial Department of Agriculture. Although Dr. Warth had in the beginning to conduct the work of the section under adverse conditions, yet the output of his work, as testified by the Royal Commission on Agriculture, was most satisfactory, both from the point of view of technical excellence and from that of practical value. He was the pioneer worker on animal nutrition problems in India, and some of his investigations, *e.g.*, on the power of digestion possessed by Indian breeds of cattle, the character of diet required by growing calves, the digestibility of Indian coarse fodders, the digestibility of fodder plants at different stages of growth and the mineral deficiency in fodders, are of far reaching practical importance in the development of animal husbandry and dairying in India. As a fitting recognition of his outstanding work, the Birmingham University conferred the D.Sc. degree on him in 1933. His retirement has been a distinct loss to the Department of Agriculture. (F. J. F. S.)

MANURES AND MANURING

BY

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INTRODUCTION

By manure is generally understood any material which ameliorates a soil or improves it for the purpose of growing crops; and manuring is a term which covers several functions, the most general one being the addition of plant foods to the soil for the use of the growing crops. There are, however, other very important aspects of the process, such as the amelioration of the soil by reducing the alkilinity of *kalar* or *usar* lands or by sweetening sour ones, the improvement of a soil's texture to enable it to hold moisture better and to supply moisture more freely to its crops, and the building up in the soil of that reserve of humus so essential to the healthy working of the various processes connected with plant life.

Under the climatic conditions of India the maintenance in soils of the stock of humus is most important. By humus we mean that portion of the organic matter in soil, the decayed and partly decayed vegetable tissue, which has so far decomposed as to have lost its vegetable structure and become a dark amorphous mass such as we see in very thoroughly rotted farmyard manure; and this humus plays a most valuable part in those processes in the soil which assist the growth of plants. It is itself a reserve of plant food, slowly and steadily becoming available for the plant's use; and it is the ideal medium in which live, and work, and multiply, the bacteria and other miscroscopic organisms which play such a great part in the changing of food materials into the form in which the plant can utilise them. It has a further very beneficial effect on the physical properties of the soil in that it gives sands cohesion and water-retaining power and makes clays more open and friable. Ample humus in a soil enables it to absorb more water, to hold it longer and to give it more freely and easily to plants, so that the excess of one storm or irrigation is absorbed and stored for the plant's use as required and plant growth can be steady and regular instead of varying with the onset of rain or irrigation.

A most important source of food supply for the bulk of India's crops is the nitrogen abstracted from the air and fixed in the soil by various groups of bacteria and this process of nitrogen-fixation, the cheapest form of manuring, only functions fully in the presence of adequate supplies of humus. At the other extreme, the proper utilisation of extra dressings of artificial manures only takes place in a soil with an adequate humus supply.

In all these respects a good stock of humus is necessary in Indian soils and yet, because of the climatic conditions, long warm seasons followed by heavy monsoon storms, there is a continual decaying of humus to form soluble salts and washing out of these from the soil. On cultivated soils everything assists the rapid loss of humus and so the keeping up of the stock of humus in our soils may be called the foundation of manuring in India.

During their growth and ripening, crops collect in themselves large quantitie of chemical elements the chief of which are carbon, hydrogen and oxygen, nitrogen, calcium, phosphorus, potasium, together with smaller quantities of many others such as iron, aluminium, magnesium, manganese, sulphur, etc. Of all these, carbon only is obtained direct from the air, all the others being drawn in some form or other from the soil, through the roots of the plants. In the carbon dioxide of the air plants have limitless supplies of carbon : but of the chief elements drawn from the soil, nitrogen, phosphorus and potash, the supplies in most soils are strictly limited, and their withdrawal by continuous cropping reduces those stocks to a point where only sufficient becomes available each season for very small crops. In manuring to feed the plants then, we are mainly concerned in adding to the soil nitrogen, phosphoric acid and potash. The other mineral constituents are essential but the amount of these substances used is so little that their supplies are hardly ever inadequate in ordinary soils. Of the main constituents potash seems to exist in adequate amounts in most Indian soils ; over large areas the soils are deficient in phosphates while almost all the cultivated soils of India seem to lack sufficient nitrogen to enable a full crop to grow without the addition of further supplies. It is important to remember in this connection that plants take up their nitrogen supplies mainly in the form of nitrates ; only paddy is known to take part of its nitrogen supplies in the form of ammonia which is itself an intermediate product in the formation of nitrates. Whatever manures we give as sources of additional nitrogen, therefore, the nitrogen-bearing constituents of the manure have to be changed by chemical and bacterial action in the soil to nitrates before the plants can utilise them.

The manures in general use may be grouped into three classes. The bulky and slow-acting ones include dung of livestock of various kinds, which when mixed with straw, etc., is known generally as farmyard manure, compost which is a product of the decomposition of all sorts of vegetable waste, and green manures which are actual crops grown specially to be ploughed or otherwise mixed into the soil. They all consist of a large bulk of more or less rotted vegetable matter containing comparatively small quantities of actual plant foods but including minute fractions of most of the elements a plant requires. The second group includes such manures as oil-cake and bone-meals and these are rather more concentrated and quicker acting but are still organic and largely of a general nature. The third class, the concentrated manures or fertilisers, are mainly commercially prepared chemical compounds or mixtures containing relatively large proportions of the main plant

foods, *i.e.*, nitrogen, phosphoric acid or potash, with little carrying material. They are as a rule quick-acting and specific, *i.e.*, in them we are applying what we think the plants need. There are in addition a few special manures, such as lime which is used to sweeten a soil by neutralising the excess of acid that may be in it, and gypsum the main value of which is in the calcium part of its calcium sulphate, though its sulphur is on some soils especially valuable.

Bulky manures are particularly valuable on most Indian soils because they fulfil two most important functions.

1. They add appreciable quantities of the main plant foods, nitrogen, phosphoric acid and potash, and also small amounts of most of the other elements the plant needs.

2. They add to the stock of humus in a soil; and this, as already noted, improves the soil texture, making heavy soils lighter and light soils heavier, in both cases improving the moisture-holding capacity of a soil and its ability to move moisture to the plants roots as required, and is the essential medium of most microbiological activity.

FARMYARD MANURE

Farmyard manure is the best known and most widely used bulky manure and is the partially decomposed mixture of the dung and urine of the various farm animals, cows, buffaloes, ponies, goats, sheep, etc., with waste fodder materials and straw or other plant residues. Of the excretions of the various livestock the urine is manurially of greatest value and the most often wasted. By making shallow pits near the cattle sheds and throwing into them a certain amount of plant refuse to absorb urine, by storing all the dung in these pits, and by draining into them the urine and washings from the stalls, the bulk of farmyard manure collected can be greatly increased. But to destroy weed seeds and to make the manure fairly quickly available it must be left in the pits over a rainy season to rot down thoroughly. When well prepared it contains 0·4 to 0·5 per cent nitrogen, 0·3 per cent phosphoric acid and 0·2 per cent potash; and if used in sufficient quantity, which is at the rate of 300 to 400 maunds per acre, will supply most of the plant foods a crop requires and improve greatly the soil's texture and moisture-holding capacity. But, as everyone knows, there is not enough of it available to manure properly the cultivated lands of India, because so much of the dung and trash required for making it is used as fuel for which there is at present no economic substitute. It is proposed therefore to discuss at greater length the best substitutes for farmyard manure, on which considerable knowledge has recently been collected.

Compost

All over India considerable amounts of waste vegetable matter are available such as stalks of cotton, *rahar*, mustard, leaves of trees and shrubs, sugarcane trash, spoiled straw or grass, etc., all surplus vegetable matter of no value even for fodder. But it can all, with simple treatment, be made into compost and compost is an excellent substitute for farmyard manure.

The rotting down of surplus vegetable material to make a satisfactory organic manure has been studied in great detail from the time of the elaboration of the Adeo process in England ; and in India the Indore process, developed by Howard, is probably the soundest method of wide applicability. For wide-spread use by the cultivators of India, however, even further simplification is possible.

The principle of compost making is to collect the vegetable refuse into heaps, inoculate these heaps with the bacteria and fungi necessary for their rapid decomposition, and by periodic waterings and turnings of the heaps make the moisture and temperature conditions so favourable that the bacteria and other organisms multiply very rapidly and the vegetable material is rotted down quickly and completely. Some materials like cotton and *rahar* stalks are very intractable and require a preliminary breaking down and softening before the decomposition processes can get at them, and in such cases it is a good plan to spread them on the roads and let carting go on over them for some months, particularly during the rains. Cane trash is difficult to get rotted because of its very woody structure and the low proportion of nitrogen it contains ; but sufficient moistening and turning of the heaps and the addition of extra nitrogen in the form of cattle dung or urine, will effect the change ; and even cane trash can, with careful working, be rotted down quickly and successfully. The sowing of *sanai* seed on the trash heap at the commencement of the monsoon, and the digging into the heap of the crop so grown six weeks later, is another good way of raising the nitrogen content and assisting decomposition.

Generally compost heaps, about 20 feet long 10 feet wide and 4 feet high, should be made either on flat ground or in very shallow pits, in rows or groups near a water supply. In building them, after every foot of rubbish add a thin layer of cattle manure or earth from the cattle standings or even old well-rotted compost to act as a starter, and moisten the heap as it grows with drainage water from the cattle sheds or other such dilute solution of urine. Moisten the heaps regularly for a few weeks and then turn them, making sure in the turning that the moisture is spread well through all the material. Further moistening and turning at fairly regular intervals of about three weeks or a month will ensure rapid decomposition and in three to six months the rubbish should be rotted down to a friable black powder like leaf mould, and this is the finished compost,

If a regular supply of water is not available the heaps should be made during the dry season ; and then, when the rains begin, be turned to let the rain into them, and thereafter be turned and mixed at intervals according to the amount of rain

that falls. In heavy rain the intervals should be longer and in light rain shorter, the whole object being to get sufficient moisture well spread through the heap. Each turning lets air into the mass and spreads the moisture and the colonies of decomposition organisms through the heap. Rapid decomposition at a fairly high temperature destroys weed seeds and also most noxious organisms, so that this method can well be used in the treatment of right soil and town refuse, to produce a fertile compost, safe and clean to use.

The final product compost is a dark brown or black friable powder, containing about 0·5 per cent nitrogen but generally less phosphate and potash. As a manure it is quicker acting than farmyard manure, though often of much the same composition ; and to give a full dressing of plant foods to the land fairly heavy dressings are necessary. [Howard and Wad, 1931]. It is very valuable in its effect on the tilth and texture of soil and the best way to utilise it is to give moderate dressings and supplement it by concentrated artificial fertilisers. The proper conversion of all the waste vegetable matter found in the Indian villages, into good compost, is probably the easiest and best way today of supplementing the inadequate supplies of farmyard manure generally available.

GREEN MANURE

A second method of increasing the bulky organic manures so badly needed is by green manuring. This means the growing of a crop on the land and turning it into the soil by ploughing or digging, so that in rotting it provides manure for the succeeding crop. A quick-growing leguminous crop is generally used, so that a big bulk of vegetable matter is added to the soil after only a short period of growth ; and the extra nitrogen which the leguminous crop collects from the air is also gained.

Many leguminous crops are used for this purpose, such as sann hemp or *sanai* (*Crotalaria juncea*), *dhaincha* (*Sesbanea aculeata*), *meth* (*Phaseolus Ricciardianus*), cow peas (*Vigna Catjang*), etc., and even some non-leguminous ones such as mustard ; but it is generally agreed all over India that, for high well-drained lands *sanai* is the best, and for wet lands probably *dhaincha*. Both grow very rapidly in the early monsoon and in six weeks or so give a large bulk of vegetable matter for rotting ; and both, in most soils, form nodules very freely and so collect from the air and add to the soil a large amount of nitrogen. In the United Provinces a properly grown crop of *sanai* is considered to add 60 to 80 lbs. nitrogen per acre to a soil. [Clarke, 1930.]

In green manuring it is important to sow the green manure as early as possible at the beginning of the rains on well-prepared land so that the crop will grow quickly, and then to plough it in six to eight weeks after sowing. It must be ploughed in before it gets woody, and while there is still enough of the monsoon left to ensure ample rain and two months of the monsoon for rotting. Where it

s used for paddy early sowing is essential, and it is puddled into the land when this is being prepared for transplanting. For *rabi* it should be sown early in June and ploughed in by the end of July and for sugarcane should be a little, if any, later. For most crops ploughing in by end of July or early August is essential; and it is better to plough in a small crop at the right time, than to wait for it to grow bigger and plough it in late. Ryots dislike green-manuring except for paddy, as it prevents them taking a food crop that *kharif* season, and experiments are being made in growing green manure crops in between the rows of food crops or commercial crops like cotton; but at present the sound plan is to persuade the ryot to green manure for valuable crops like cane and tobacco. where the increased crop obtained will pay a handsome profit on the cost of the green-manuring even after allowing for the sacrifice of the food crop.

An important variation of green-manuring is the growing of leguminous fodders such as *meth* or *kalai* grazing them on the land by livestock, generally cattle, and ploughing in the crop residues and the cattle dung and urine dropped on the field. Such a practice is, in Bihar, an excellent preparation for tobacco and other *rabi* crops, and also for cane; while in irrigated tracts the growing of berseem, the grazing of the successive growths, and the final ploughing in of the residues and manure, is well known as an excellent way of improving the land. The practice would undoubtedly spread on a large scale if the live-stock products such as milk and ghee, or the cattle themselves, commanded a better market.

OIL CAKES, ETC.

The second class of manures valuable on Indian soils are those like oil-cake and bone meals which contain fairly high percentages of the plant foods and at the same time a certain bulk of vegetable matter of value in improving soil texture. Experiments on the Agricultural Department's farms all over India, have clearly established the result that finely powdered oil-cake is valuable as a manure, to the extent of its nitrogen contents, on most commercial crops; and it is already the practice of the cultivator to use oil-cakes for special crops in fair quantity. At 10 to 15 mds. per acre, castor cake with 5 per cent nitrogen, 3 per cent P_2O_5, and 2 per cent potash, is largely used for sugarcane all over northern India; and where castor cake is not readily available, mustard cake 4 per cent nitrogen, is largely used, though the value of this cake as a bullock food restricts its use as manure. *Karanj* and *mahua* cakes, with 3 per cent nitrogen, having no value as cattle food, can often be got sufficiently cheaply to be useful manures. Oil-cakes are particularly important in that they are made in most villages and so are available cheaply, to some extent almost everywhere. But in using village supplies it should be remembered that they are often imperfectly pressed and a high oil content makes them slow acting. In the same way fine grinding increases the rate at which they become available. Bone meals are usually fairly finely crushed, well-

weathered bones, containing about 20 per cent P_2O_5 and 4 or 5 per cent nitrogen. Though mainly of use as supplying phosphates, their nitrogen is valuable and they are slow acting and persistent. They are excellent for permanent crops like fruit trees; but the price is relatively high and the return from them slow; so that the ryot, who must get a quick return for his expenditure on manure, is generally better advised to use oil-cake and artificials to supplement his cattle dung.

Lime is not generally needed as a plant food but is valuable for neutralising acidity in soils, so making them more able to support the bacterial life so essential to plant growth. The laterite soils and those derived from these which cover so large parts of central and south India, are markedly acid and lime at one ton per acre every 4 or 5 years, improves their cropping power greatly. Gypsum, a crude calcium sulphate extensively mined in Rajputana, contains a fair proportion of free lime and is valuable on those acid soils. Its sulphur also seems specially useful but its value is wider than this. On heavy soils gypsum has a valuable effect in flocculating the finer clay particles and so improving the soil's physical texture; and its calcium sulphate, on many alkaline soils, reduces the alkalinity and so ameliorates *usar* or *kalar*. Both lime and gypsum are valuable both for their physical effects and for their neutralising power.

Artificial manures

The third main class of manures are what are called artificial manures or fertilisers; and those are chemical compounds, generally manufactured, and containing relatively large amounts of important plant foods and correspondingly small amounts of carrying matter. Their value is almost entirely in the plant food they supply; though some, having an acid reaction, also tend to counteract soil alkalinity met with as *kalar* or *usar*. They are generally very quick-acting and so can be applied at sowing time or in the case of long-growing crops like sugarcane, in small doses when the crop is making its most rapid growth.

The chief nitrogenous artificials are ammonium sulphate with 20 per cent nitrogen, and nitrate of soda with 15 per cent. The phosphatic ones are superphosphate with 22 per cent P_2O_5, and double super with twice that amount. The cheapest quick-acting source of potash is sulphate of potash with 50 per cent K_2O. Because during the Great European War, the processes of commercial fixation of nitrogen from the air were enormously developed and commercial ammonium sulphate is now-a-days a very cheap source of nitrogen. Further processes have been developed for combining phosphates with ammonia produced from air, and consequently we have available very cheap combined manures containing both nitrogen and phosphoric acid. Niciphos II, containing about 18 per cent of each, is the cheapest commonly available one, and has been shown in Bihar to be a very valuable manure for both sugarcane and *rabi* crops. On sugarcane reliable trials over many years have shown that a dressing of 3½ mds.

per acre, gives invariably 100 per cent profit on its cost. Further west in the United Provinces and South, in Bombay and Madras, where shortage of phosphate is not so acute, ammonium sulphate alone has proved to give very striking profits on most crops. On the paddy soils in Burma Niciphos has given excellent returns; and generally it is being found that for crops, still fairly high priced, top dressings of ammonium sulphate or in certain areas like North Bihar, of Niciphos II, almost always give a very profitable increase of crop.

Valuation of manures

The bulky manures are usually prepared by the cultivator himself who will make his own farmyard manure and compost, and grow his own green manures; and their value will depend partly on their manurial ingredients and partly on their condition; while as noted before, the bulky manure have considerable value in improving soil texture. But the more concentrated manures have usually to be bought and as their value is almost entirely for the plant food they contain, it is important to be able to estimate which is the cheaper to buy. The prices used below are those just quoted in the Muzuffarpur bazar.

Ammonium sulphate costs say Rs. 4-8-0 per md. and contains 20 per cent nitrogen, *i.e.*, 8 seers nitrogen in this form will cost Rs. 4-8-0 or nitrogen in ammonium sulphate is annas 9 per seer.

Double superphosphate containing 40 per cent P_2O_5 costs Rs. 14-4-0 per 2 cwt. bag, so that in this form 1 seer readily available phosphoric acid costs annas 0-5-1.

On that basis niciphos II containing 18 per cent nitrogen and 18 per cent P_2O_5 contains 7·2 seers nitrogen worth Rs. 4-0-9 and 7·2 seers P_2O_5 worth Rs. 2-4-7, *i.e.*, its total value is Rs. 6-5-4 per maund. Hence, quoted at Rs. 6-6-0 per maund it is exactly the same value as the corresponding mixture of ammonium sulphate and super.

Castor oil cake contains 5 per cent nitrogen and 2·5 per cent P_2O_5 so that a maund will contain 2 seers of nitrogen at As. 9 per seer and 1 seer P_2O_5 at As. 5/1 or its total value is Rs. 1-7-1 per maund. The potash is probably not required but its humus has some value so we can say it is probably worth about 1-10-0 per maund and if its price is quoted higher than that, it is cheaper to buy ammonium sulphate and superphosphate or Niciphos II. Of course in such calculations the freight to the local station should be included.

General

Lack of space prevents an attempt to give detailed instructions for the manuring of different crops all over India, but there are certain general principles which apply everywhere and which should be followed under all conditions of Indian

agriculture. The first of these is that practically all cultivated soils, excepting those receiving regular silt deposits, require continual renewal of their stock of humus. With that single exception, therefore, all soils in regular cultivation require at regular, frequent intervals, say every 3 to 5 years, a dressing of 300 maunds per acre, say, of bulky manure. As much cow dung as possible should be properly preserved for this purpose and as much compost as possible made to help the supply. If these two together do not give sufficient for the above dressing a green manure crop should also be grown in the rotation, and it pays to grow this green manure crop at the stage when it will give the most immediate return, such as before the cane crop, or for tobacco or other such valuable *rabi*. The keeping up of the stock of humus in the soil is vitally important and all recent experimental work shows how valuable the practices of compost-making and green-manuring are for the purpose.

Secondly, the bulky manure dressings need to be supplemented by particular fertilisers for certain crops and circumstances. For example in North Bihar our soils are short of phosphate and our farmyard manure and green manure seem to contain less phosphate than nitrogen. It pays us therefore for cane, the crop which at present pays best for manure, to supplement our bulk manures with superphosphate at planting and further to give a small top dressing of nitrogen and phosphate when the cane is making its most rapid growth early in the monsoon. On maize, a little quick-acting nitrogen just at the time in July when the maize is shooting, always increases the yield. On potatoes, though the bulky manure has been given, a little quick-acting mixed manure like oil cake or niciphos II given at planting time, seems always to be beneficial. On *rabi* cereals a dressing of 1½ maunds per acre Niciphos II at sowing seems always to give an extra 4 or 5 maunds of grain per acre in the crop.

CONCLUSION

It is being realised of recent years that the increased yields given by the improved varieties of crops introduced by the Agricultural Departments, such as the Co. canes and the Pusa wheats, are resulting in a lowering of fertility of the soil in the tracts where these improvements have been adopted. To counteract this tendency, to enable those lands to continue to give heavy yields of the improved crops, and all lands to give better yields of the common crops grown, regular systematic manuring is necessary. Firstly all farmyard manure that can should be saved, as much compost as possible be made and occasional green manure crops be grown and ploughed in to build up and keep up the stock of humus. Then, for special crops that even to-day pay handsomely for them, such as sugarcane, tobacco, chillies, potatoes, improved cottons, etc., oil-cakes or fertilisers should be bought, carefully, according to their local price and manure content, and generally

after taking the advice of the local agricultural officer. Even to-day careful intelligent manuring of his land, building up its stock of humus and feeding certain special profitable crops, is one of the best investments, an insurance against climate and a profit-making investment the Indian cultivator, large and small, can make.

REFERENCES

Clarke, G. (1930). *Agric. J. Ind.*, **25**, 89.

Howard, A and Wad, Y D (1931). "The Waste Products of Agriculture"

EFFECT OF MANAGEMENT ON THE MILK YIELDS OF DAIRY CATTLE IN INDIA

BY

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BRIEF DISCUSSION ON CERTAIN FACTORS—APART FROM BREEDING—INTIMATELY CONNECTED WITH THE IMPROVEMENT OF DAIRY CATTLE IN ADVERSE ENVIRONMENTS

In breeding dairy cattle, too much reliance is sometimes placed on the system of breeding and insufficient attention is paid to certain other fundamental factors. The more adverse the environment, the more important do such factors become. Over the greater portion of India, the environment is not favourable to the breeder, and it is, therefore, advisable to discuss the effect of these factors and their correlation to each other. If much I say appears obvious, I make no apology because the obvious is so often forgotten and complicated answers are sought for simple problems.

The correlation between certain fundamental factors may be expressed by the following equation :—

$$\frac{\text{Constitution of dam} \times \text{Management}}{\text{Climate} \times \text{Prevalence of disease} \times \text{Calving interval} \times \text{Milk yield}} = \frac{\text{Constitution of progeny} \times \text{Management}}{\text{Climate} \times \text{Prevalence of disease} \times \text{Age on first calving}} = \frac{\text{Success}}{\text{Failure}}$$

of heifer as a dairy animal on calving.

Constitution of dam

The constitution of the dam is the foundation on which the breeder must work; all factors below the line in the equation tend to weaken this foundation.

Climate

Climate is governed by latitude, modified by local conditions, such as altitude, distance from the sea, ocean currents, the direction and temperature of prevailing winds, aspect and, most important of all, rainfall. The approximate ideal climate for dairy cattle has a temperature range from 32°F. to 98°F. and a rainfall between 25-30 inches, distributed evenly throughout the year, at an altitude not over 3,000 ft. above sea-level.

The more adverse the climate, the greater is the strain on the constitution.

Age on first calving

The earlier the age at which an animal first calves, the less is its capital cost, but the constitutional strain is increased.

Calving intervals

Up to a point, decreasing the calving interval increases the economic value of a dairy animal, but it also increases the strain on the constitution.

Milk yields

The production of sufficient milk to cover costs and leave a margin of profit is essential, if a dairy animal is to be economical. The exact quantity of milk that must be produced to cover costs will, naturally, depend on local costing factors. The economy of milk production increases, with increasing yields, to a peak which might be called the "peak of maximum profit"; after the peak is reached, the economy of milk production decreases. The height of the peak will depend on the individual animal, correlated with other factors in the equation, always bearing in mind that the foundation must remain intact.

Prevalence of disease

Every attack of disease is a strain on the constitution. Unfortunately, prevalence of disease and an adverse climate are generally found together.

Management

Referring to the equation, it is clear that the inherited constitution of the progeny can only be increased if the effect of the sum total of the factors below the line is less than the effect of skill in management. It is also obvious that if the economic factors of age of first calving, calving intervals and milk yields of a herd are to be progressively improved, then the constitution of the dams must be preserved.

It will be generally found that indigenous cattle, in their fight to live, have curtailed the constitutional strain from these economic factors, in proportion to the adversity of their environment.

By utilising the reserve of constitution, found to a greater or lesser extent in all indigenous animals, economic factors can be spectacularly improved by crossing the indigenous cattle located in adverse environments with imported breeds, with an inheritance of high value economic factors, gradually built up in advantageous environments. However, unless the skill in management is of a very high order and the temptation to make the most of these inherited high value economic factors is curbed, a constitutional break-down is inevitable in one or at the most two generations. This to a large extent, explains the many failures in crossing European breeds on indigenous cattle in India.

Although the inherited constitution of the progeny can be improved by skilful calf management, it must be realised that management has technical as well as economic limits ; these limits must be exactly understood by the breeder, and in a given locality, if progress is to be made, the maximum limits of the economic factors must be fixed to ensure that the inherited constitution of the progeny is not less than that of the dam.

From a study of the equation it appears clear that, in adverse environments, skill in management must precede skill in breeding. Constitution is of a paramount importance; the more adverse the environment, the smaller is the constitutional reserve in indigenous animals and the surer and quicker will be the break-down if the constitutional strain of the economic factors is increased, without prior improvement of the constitution, to withstand the increased strains. These elementary facts, of what might be termed, the mathematics of breeding in an adverse environment, are not always remembered by breeders anxious for quick results.

Therefore, in adverse environments, the starting point of the breeder is not the dam but the calf. The constitution of the dam is, for practical purposes, fixed; and it is unwise to increase the strain on the dam by attempting to increase its economic factors artificially. The inherited constitution of the calf should be increased by skilful management over several generations, and the economic factors gradually improved by skilful breeding up to the limit imposed by local conditions.

Improving the Constitution of the Calf

It is an unfortunate fact that although skilful calf management is the basis of breeding improved dairy cattle in an adverse environment, it is probably the most neglected branch of dairy husbandry in India. Indigenous cattle, in their fight to live, have reduced their milk yield and other economic factors in proportion to the adversity of the environment. The owner, in his fight to make a profit out of such animals, has reduced calf-management to the art of keeping the calf alive on the minimum quantity of milk. In urban areas where maintenance costs are higher and milk more valuable, this tendency is so exaggerated that starvation is the recognised primary cause of the high mortality amongst calves.

Adverse environments produce indigenous cattle with poor milk yields ; if the owner is to make a profit, a poor milk yield means that insufficient milk is fed to the calf ; if the calf is semi-starved, the inherited constitution is impaired, and on maturity the calf has a worse constitution than its dam ; this in turn means poorer milk yields when the calf reaches maturity, and so the vicious circle goes on until, in the struggle for life, stability is reached with miserable cattle and miserable owners.

To break the vicious circle is a question of economics as well as technique; the commercial owner is not going to starve himself to feed the calf, for some gain in the future; yet, without building up the constitution to stand the strain of improved economic factors, permanent progress is impossible.

It is, therefore, essential to introduce and encourage the owners of dairy cattle in India to use some system of calf-rearing that will improve the inherited constitution, but yet, will not be so costly as to absorb the small margin of profit in maintaining dairy cattle of the present standard.

It is well known that although whole milk is essential for a certain initial period of a calf's life, it is practicable to replace gradually whole milk by less expensive substitute without endangering the constitution. Separated milk is the most widely used of these substitutes.

To take full advantage of the economy in feeding separated milk, it is essential that the calf should be weaned at, or within a few days of birth, and hand-reared.

Hand-rearing

Although it is unfortunate that there should be a considerable amount of prejudice in India against hand-rearing of calves, it must be recognised that there are certain economical problems to be solved before this prejudice can be overcome.

Competition in the urban milk trade is ruthless, the majority of milk-producers are in debt and ground between the greed of the money-lender and the low purchasing standard of the consumer. In these areas, the milk-producers' ability to exist depends much more on cunning and skill in adulteration than on skill in cattle-management. Separated milk is largely used as an adulterant of whole milk and, therefore, commands a comparatively high price. A stricter application of the pure food laws would not only protect the consumer, ease up competition and enable the milk-producer to regain his self-respect, but would reduce the value of separated milk and encourage its use as a calf food.

In rural areas, where there are very few separating machines, creameries would have to be established in favourable cattle-breeding centres, and the manufacture of ghee from cream, instead of milk, actively encouraged. Owing to the fact that the average milk-producer in India is not unduly worried by any desire to produce clean milk, it is advisable to have the separator as close to the calf as practicable. A separator in each village is the ideal, an ideal by no means visionary, because it rests on a solid economic foundation.

It is often stated that, with cattle in India, it is impracticable to wean calves at birth, because the dam almost invariably goes dry and weaned calves are difficult to rear.

It is true that, if indigenous cows allowed to suckle their calves, forceable weaning later on may reduce or even stop their milk yields during that lactation, and there may be some difficulty in teaching the calf to drink by itself; but, if

the calf is weaned at birth, lactation yield will only be affected in about 10 per cent of the cases.

It is rare that a buffalo is upset by her calf being weaned, and in practically no case should a cow or a buffalo, on first calving, be affected by having her calf weaned at birth.

It must always be remembered that it is not in the interest of the hired milker to prove that weaning calves at birth is practicable. With the removal of the calf from the milking shed, the whole standard of calf-management can be improved, hygiene of milking is simplified, and accurate data on yields are collectable. This combined atmosphere of cleanliness and check is entirely repugnant to the red hand, and unless the owner is firm, weaning of calves at birth will be shown to be an economic disaster.

Standard by which the efficiency of calf-management may be judged

The best guide to the efficiency of calf-management is the rate of growth, and the best means of checking the rate of growth is by periodic weighments.

Other things being equal, the better the growth rate, the better the constitution and the more milk an animal can produce without strain when mature.

The first year of a calf's life is constitutionally the most important, and growth must not only be up to standard at the end of this period but the rate of progress must be regular. Irregularities in the weight curve are due to inherited constitutional defects, illness, or improper feeding, and generally produce constitutional weaknesses. These constitutional weaknesses may be hidden by a rapid increase in the growth-rate when the animal is more mature ; but such animals often break-down when producing higher yields, or if they safeguard their constitutions, they are disappointing milkers.

The rate of growth has practical and economical limits depending on the breed and local conditions.

Table I shows the minimum growth-rates expected from birth to one year, amongst female calves in the government military dairy farms, and is given as a guide :—

TABLE I

Growth-rate from birth to one year (females)

Breed	Increase in weight per week
Sahiwal	8 pounds
Murrah buffalo	9 ,,
Cross breeds	11 ,,
Friesians	14 ,,

The effect of manures on sugarcane in North Bihar.

Green manure + Artificials   No manure   Green manure only

Fig. 1

Green manure + Artificials   No manure   Green manure only

Fig. 2.

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Lahore Justice.—A $\frac{3}{4}$ bred weighed 722 lbs. at one year. Gained on the average 12·6 lbs. per week. Present age 1 year and 10 months, shows great constitution.

A group of calves showing uniformity of growth and constitution Average weekly gain in weight since birth 11·1 lbs Average age 47 weeks.

A group of cross bred calves showing plenty of constitution Average weekly gain in weight since birth 11.2 lbs Average age 46 weeks

Cost of improving the constitution of the calf

It naturally follows that constitution-building costs money, but, from data available in the records of the government military dairy farms, it has been proved that by feeding calves, to maintain regular growth increases of not less than those given in Table 1, the extra cost involved is recouped within two lactations.

Plates XXV, XXVI and XXVII show calves reared at the Government Military Dairy Farm, Lahore Cantonment. These calves will, on maturity, soon repay the extra cost of constitution-building.

Technique of hand-rearing

In this short article it is only possible to summarise the more important points which the breeder must watch if the growth-rates of hand-reared calves are to be satisfactory.

(1) The calf should be weaned at birth.

(2) The calf-pen and all feeding utensils should be kept scrupulously clean.

(3) The calf should be fed on the dam's colostrum for the first five days.

(4) The time between drawing the milk and feeding it to the calf should be as short as possible, and the better the hygiene of handling milk, the better the calf will thrive.

(5) The food given must be adequate in quantity.

(6) The calf should be weighed every week and the weight recorded on a chart. Calves not thriving should be given special attention.

(7) The calf must be protected from adverse climatic conditions, as much as possible, by being given suitable accommodation.

(8) It is unwise to attempt to rear more calves than can be given adequate attention and food.

(9) Improved growth-rate decreases age of maturity but undue advantage should not be taken of this factor, especially in the initial stages of constitution-building. An age and weight limit should be set to prevent young stock being served too early.

Final

It is the hope of the writer that this short article may encourage some cattle-owners to think less of immediate profits and more of the quality of their future herds, and will stimulate the hand-rearing of calves. Without hand-rearing, the writer can visualise no permanent progress for the dairy industry in India.

Cattle-owners wishing for more detailed information on the subject of building up constitution are invited to visit any of the government military dairy farms in the writer's charge; where, under commercial conditions hundreds of calves are hand-reared every year, and growth-rates, equal to those obtained in more advanced dairy countries, are obtained as a matter of routine, and where the subsequent lactation yields are proofs of the economical soundness of building up the constitution of young stock.

REMARKS ON PRIMARY CULTIVATION UNDER INDIAN CONDITIONS WITH SPECIAL REFERENCE TO SOIL INVERSION*

BY

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FOREWORD

In recording this survey of experimental work in as far as it relates to the primary tillage of soils in India together with the impression left on him after many years of personal observation of cultivation practice, the writer desires to express his thanks for the invaluable assistance accorded him by the Directors of Agriculture of Bombay and Madras and the members of their staff who collected the necessary data from the records of these departments.

R. G. ALLAN,

Director of Agriculture, United Provinces.

* Mr. Allan's article not only brings together and attempts an interpretation of the results of a number of scattered experiments— very few of which were laid out on modern lines—but also embodies the results of many years' personal experience in cultivation experiments under Indian conditions. Whilst a certain number of definite conclusions have emerged from this examination of existing data, the need for modern field experiments on this important subject is made abundantly clear. Nor is this the only class of experiment for which there is an obvious need. The so-called "black-cotton" soils of India have many peculiarities and their study by modern physical methods would probably well repay the effort. (Ed.)

Ploughing

The initial step in cultivation.

The position of soil inversion and deep ploughing in Indian practice.—There are three types of primary tillage in evidence in different parts of the world where animal power provides the draught: (1) Inversion, (2) Soil stirring, and (3) Soil paring.

(1) *Inversion* is secured in two ways :—

(*a*) by means of an implement by which a slice of the soil is cut out by the interaction of a vertical knife or sharp edge (the coulter or shin) with a horizontal cutter (the share wing) and subsequently subjected to a twisting motion created by the shearing effect, on the soil particles, of an attachment linked with the shin and share termed the mould-board. The shape of the furrow may be altered by the manner in which the plough is handled. The completeness of the inversion of the slice and its state of wholeness or brokenness is largely dependent on the shape given to the mould-board which, according to needs, may take any form varying from the long convex shape to the short abrupt form in which the curve of the board, at the point where it meets the rising slice cut by the shin and share, is concave.

(*b*) by the utilization of a large saucer-shaped revolving disc set at an angle to the direction of movement of the plough and at varying degrees out of the vertical. This disc depends a good deal on the general weight of the implement for its vertical penetration, but assuming that the soil crust is not unreasonably hard and that penetration is secured, its progress through the soil results in a fair inversion accompanied by very marked shearing and, in consequence, pulverisation of the soil through which it passes.

Implements of both these types call for definite attention to adjustments, according to the character of the soil in which they are working and to the results aimed at, if the best work with the least strain on the draught animals and on the ploughman is to be secured. This is particularly the case in hard soils, and lack of this knowledge is one of the chief causes why better results are not attained with inversion implements in India.

(2) *Stirring*.—In this type of tillage the soil surface is broken up by a pointed tyne or series of tynes drawn through the soil and operating as wedges, breaking out triangular rather than rectangular furrows. The cutting or breaking is vertical and the action is one of digging and gently lifting. It is virtually the shin and share point of the first class without the share wing and mould-board. It is the essential principle of the Indian plough, the cultivator and the knifer. The movement of the soil is less pronounced as it is largely a matter of stirring *in situ*.

(3) *Paring.*—In this type the soil surface is scraped or undercut in a horizontal direction by a knife set at an angle with the soil surface. This knife is either an actual blade working through the soil, as a razor is used in shaving, or is a tyne more of the duck-foot type than that of No. 2. In the second or stirring type of tillage, it is a case of the point tending to dig and lift the soil. In the paring type, though the point, a feature common to most tynes, exists, most of the work is done by the flat wings sloping backwards from the point. The earth is thus rather undercut by the wings than lifted by the point. Actual soil displacement is less in this type of tillage than in either (1) or (2). This implement has not the depth tendency of the others and is at its best when the soil is soft. It is, in fact, a form of blade harrow which is being used for primary work. The *bakkar* of the Deccan, the *guntaka* of Madras, the Kentish broadshare and the modern paring plough are examples in which this principle is employed.

In comparison with these types and as exemplified by hand tools we have the spade and *phowra* with which the earth is dug vertically and turned, the fork by which it is loosened rather than actively turned, and the shovel generally employed to move loose earth in which the application of the blade is in a horizontal direction.

Of these the second or stirring type is undoubtedly the earliest form. It is a principle which dates back to the time when man first converted his pointed hand-used stick into an animal-drawn implement. It was the only form in use until early in the 18th century when the rudimentary forms of the inversion type made their appearance in Western Europe. The inversion type, in its modern form, is the primary cultivating implement of tillage in Europe (with the exception of parts of Greece, and the Balkan States), both the American continents, Australia, and, to a very considerable extent, in South Africa, Egypt, and Russia in Asia. The older, stirring type still persists as the dominant implement in that part of Asia which lies south of the mountain ranges from the Himalayas to the Caucasus. In China and Japan hand cultivation predominates, and in Central Africa it is probable that as they are not firmly established, what there may be of indigenous implements of the stirring class will give way to inversion implements.

The third or paring form is more restricted. The principle is in evidence in the Kentish broadshare and is in restricted application in Europe, but its utilisation on a large scale is mainly limited to soils on the Deccan trap formations in Bombay, the south-west of the Central Provinces and Hyderabad, parts of Central India and Bundelkhand and on the light dry soils of the Madras Presidency. Its rather close restriction to certain areas, especially to the soils on the trap, may be associated with the behaviour of these soils in the hot weather and their marked tendency to crack. The process of scraping, while breaking up the surface layer in the dry season, also produces a gradual form of soil change by shovelling year after year a certain proportion of the surface soil down these very definite cracks and thus providing a new layer to be subjected to the undercutting process after the rains break and the implements can penetrate deeper.

This last type of penetration is definitely shallow, as, though under suitable soil conditions some of the newer forms undercut to 5 and 5½ inches, in the main, 4 in. represents the usual maximum penetration. The chief advantage of this type of tillage is that it permits of rapid work—an important consideration in the tracts where it is most in use. In those tracts, for example, quick preparation of the land for *kharif* sowing is essential, as sowing must be done as soon as possible after the monsoon has definitely set in. Again in these tracts the preparation for *rabi* or autumn-sown crops, when the rains are over, is to all intents a process of paring off successive layers of soil as this dries under the influence of the sun, so as to produce not so much a bed in which the seed will be laid as a blanket or soil mulch from 2-3½ in. deep under which the seed will eventually be sown on a bed which, in as far as soil is measured by the depth stirred, may almost be described as the firm or scarcely touched sub-soil or, at best, the lowest layer of earlier and possibly deeper cultivation in the rains—in short the thin new layer made possible of utilization by the shovelling down of some of the original top soil into the cracks in the hot season, as referred to earlier.

One of the principal defects of this type of primary shallow cultivation in a tropical soil rests in the inability of the thin layer produced to absorb the early rains, especially if these are heavy. Beneath the prepared top at this season is a layer of more or less air-dried soil in a hard dry condition. Even though the natural cracking helps, it takes some time to push out the air and allow the rain water to penetrate. A layer of loose soil, 5-6 in. deep, is able to take up a considerable fall, which then proceeds to work downwards, driving the air out, and so permits subsequent falls to be absorbed. On the other hand, the 2-3 in. of prepared surface soon gets surcharged and the balance of the rain cannot pass into the sub-surface sufficiently quickly and so tends, if the land is undulating, to flow down the slope between the surcharged surface and the unpenetrated sub-surface, carrying the surface soil with it. The result is to stimulate erosion to a more marked degree than when these soils are worked by either of the other two methods, particularly if such working has been at right angles to the fall of the land.

This form of primary cultivation will be mentioned again when the influence of the form of primary cultivation on crop yields is considered; but for the most part the intention of this note is a study of the evidence as to whether stirring or inversion is the better type under Indian conditions and an examination of the conditions under which it would appear that one or other is the better practice.

One of the first considerations to be examined is depth. In the majority of experiments which have been examined greater depth and inversion have gone hand in hand and it is at times difficult to be certain as to whether the factor determining on increased yields, or the reverse, has been the depth and an increase in water retention, or inversion stimulating bacterial and other reactions. It may, however, be mentioned in passing that the adverse effect of bringing up raw subsoil, so commonly in evidence in colder and temperate climates as the outcome of

increased depth, does not appear to be common in India. Increased depth, except in one or two cases, has not tended to any reduction in yield from this cause in so far as *rabi* crops are concerned. In the case of *kharif* crops such reduction of yield has occurred not infrequently in the writer's experience ; but here again this falling off, compared with former shallower work, has not been brought about by a raw sub-soil, as in temperate climates, but by the undue retention of water in the deeper cultivated soil, or other causes.

Depth can be secured by the use of either type. The chief difference lies in the fact that increased depth can be attained more easily by the modern iron plough, if of correct design and weight, than by the indigenous forms of stirring ploughs. Much less power is required to reach a certain depth and completely move the soil in so doing, whether this greater depth is attempted in one operation by a heavy implement or by several applications of a lighter one.

For example, on the black soils of the Deccan, the area associated in the main with paring work, it is and has been for a long time a recognised practice to cultivate once in eight to ten years to a depth of 7 in. to 9 in. For this purpose the farmer used an enormous wooden plough like the ordinary *nagar* but weighing 2 to 3 maunds. This is operated with very considerable physical exertion and calls for at least four to five yoke of oxen and breaks up only about 1/6th of an acre per day. This plough though common 30 years ago, is now practically extinct in Berar not because it could not get the necessary depth, but because its place has been taken by the iron inversion plough which, operating with 2 to 3 pairs of bullocks does better work and more work in a day.

The inversion plough has its association with depth because it is easier and cheaper to secure the desired depth and because, roughly, in one operation it accomplishes the work which calls for two operations of the indigenous form, though, unless the inverter is of the disc plough type, the state of the turned soil is rougher than that secured by two workings with the country plough.

To invert, however, does not demand great depth. The depth secured by the Meston plough, for example, is not materially greater than that of the *nagar* working under similar soil conditions ; or again, the depth of ploughing on the prairie wheat fields, though an inversion plough is used, rarely exceeds 5 in. and is oftener nearer 4 in.

In many of the experimental field investigations done by the departments of agriculture in India in which indigenous and introduced ploughs have been under comparison, the use of the latter has introduced not merely inversion but soil movement to a rather greater depth. Two factors thus come into play. One is the deeper work which increases the water-absorbing capacity ; the other is the deeper aeration and inversion, tending possibly to more rapid bacterial reaction on the humus of the soil, a greater drying-out tendency of the cultivated zone in the absence of rain, and the provision of possibly a larger supply of immediately available plant food.

Experimental work in the United Provinces

The experiment recorded below which was carried on for 10 years on the Gangetic alluvium at the Cawnpore Experimental Station, has the advantage of separating the inversion and depth factors, as two depths have been attained with each type of implement. The results are interesting as they show the effect of depth and the distinctly bigger effect of inversion. In passing, as it will appear later in other experiments it may be noted that this experiment was carried out on land of more than average fertility. Another point to be noted is that the shortage or otherwise of monsoon rain as affecting the water-supply did not operate as the wheat crop was irrigated. This possibly caused the smaller effect from the depth difference. In that case we must interpret the influence of inversion as tending to provide a larger amount of available plant food. The soil is typical of that found over considerable areas of the Upper Gangetic plain and no question of the eradication of persistent perennial weed was involved. Results up to 1932 are given below.

Wheat

Harvest	With inversion				Without inversion			
	6 in.—7 in deep deep ploughing		4 in.—5 in. deep shallow ploughing		6 in.—7 in. deep deep ploughing		4 in.—5 in. deep shallow ploughing	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
1923 .	1,337	2,960	1,430	2,810	1,187	2,230	1,100	2,067
1924 .	1,410	2,330	1,235	2,157	1,012	1,722	845	1,427
1925 .	1,837	3,175	1,932	3,475	1,593	2,611	1,638	2,479
1926 .	1,946	3,544	1,565	2,948	1,510	2,645	1,363	2,522
1927 .	1,720	2,840	1,635	2,601	1,301	1,972	1,110	1,738
1928 .	1,243	2,663	1,008	2,432	881	1,971	725	1,687
1929 .	2,135	3,359	2,182	3,535	1,832	3,215	1,956	3,400
1930 .	2,154	3,720	1,882	3,334	1,661	2,889	1,613	2,955
1931	1,745	3,251	1,695	3,201	1,465	2,716	1,267	2,222
1932 .	2,325	3,934	2,467	4,304	2,144	3,749	2,267	3,992
Average 10 years .	1,785	3,177	1,703	3,080	1,459	2,572	1,382	2,449
	130		123		106		100	

Gram

Harvest	With inversion				Without inversion			
	6 in.—7 in. deep deep ploughing		4 in.—5 in. deep shallow ploughing		6 in.—7 in. deep deep ploughing		4 in.—5 in. deep shallow ploughing	
	Grain	Straw	Grain	traw	Grain	Straw	Grain	Straw
1925 .	2,360	2,513	1,858	2,664	2,203	2,990	1,860	2,632
1926 .	2,350	2,322	2,506	2,826	2,460	2,210	2,460	2,877
1927 .	1,844	2,523	1,348	1,981	1,354	2,074	1,147	1,442
1928 .	2,069	1,928	2,236	2,109	2,100	1,683	2,263	1,907
1929 .	1,143	2,523	1,054	2,166	951	2,020	843	2,369
1930 .	1,815	1,733	1,785	1,585	1,675	1,763	1,820	2,157
1931 .	802	1,798	938	1,901	486	1,724	507	1,915
Average 8 years .	1,692	2,072	1,624	2,091	1,557	1,978	1,540	2,159
	109		105		102		100	

Yield in lbs. per acre

In this experiment, after the first two years, wheat and gram were rotated, the wheat plot of the first year being the gram plot of the following one and *vice versa*. Fertility was maintained by the gram plot. The area at the opening of the experiment was at a good level of fertility. Apart from the initial cultivation or cultivation to secure the required depths, subsequent treatments, tillage and irrigation were alike.

As regards wheat, there is a very distinct increase as the outcome of inversion at either depth. Relatively, the gain by inversion to 4—5 in. over stirring to this depth is as great as the like difference at greater deptn. The increase on a cereal like wheat secured by greater depth in either type of ploughing is insignificant. Inversion at either depth invariably gave a *plus* result varying from +943 to +150 at 6—7 in. and +542 to + 200 with ploughing at 4—5 in. The average

increases in the first five years were 331 and 352 lbs., the shallower being the better, while in the second period these figures were 324 lbs. and 281 lbs., possibly indicating some falling off in fertility. In regard to depth, the advantage in either type of ploughing on these soils is but slight and is certainly not significant. In four years, with inversion, increased depth gave a lower yield, and in three years without inversion a like result took place. The slight increase in cost in the case of inversion was covered many times by the yield secured.

In regard to gram, the results are less definite. There is, however, the same general tendency in favour of inversion at their depth over simple stirring. There was a consistent though less marked gain through inversion, the advantage being possibly relatively steadier at 6—7 in., whereas in five years out of eight deeper stirring alone gave either no advantage or a *minus* result.

The net result of this experiment fully justifies the establishment of a plough of the Meston type as the standard for normal crop cultivation, other than possibly cane or potatoes, in the Gangetic alluvium.

There is no getting away from the fact, brought out by this experiment and others, that the use of the inversion plough does increase the return under certain conditions, apart from the other point which is also supported by the Punjab figures, that it reduces working costs in reaching a certain standard of cultivation.

The real question, however, is not whether inversion or inversion accompanied by greater depth increases yields, but whether these practices will continue to do so, if steadily persisted in. If not invariably so, then, under what conditions can they be kept (*a*) in regular use, (*b*) for occasional operations? And, again, are there field and seasonal conditons which may, for reasons associated with the welfare of the crop or its handling in the field, make it better practice to cultivate by the indigenous implement, or some western model embodying like principles?

For a closer examination of these problems, we must refer to the consolidated records of experiments in the Central Provinces. These records cover a period of 30 years from 1900-30, and were compiled by the writer when he was serving there. For other provinces a like consolidation and analysis of results was not available and for any data that are included in this paper the writer has to thank the Directors concerned for having had them dug out of the archives and farm reports. On the whole, considering the importance of the points at issue, such experiments have not been particularly numerous and have usually been conducted for too short periods to afford fully conclusive evidence.

Experimental work in the Central Provinces

In this area the major part of the experimental work has been directed towards a study of preparatory tillage for *rabi*, or autumn sowing subsequent to the close of the monsoon. In these studies all three types of primary implements

have been involved. They differ from the United Provinces experiment in that there has been a difference in depth in addition to a difference in the matter of soil movement, both factors being studied together and not separately. Further, the majority of the work was carried out under *barani* or unirrigated conditions so that the free effect of greater depth of tillage on the moisture supply should be approved. In the United Provinces experiment the *rabi* crop was irrigated so that any advantages associated with greater depth, as helping to increase the moisture content of the soil preparatory to *rabi* sowing, may have been neutralized.

In the Central Provinces the implements under comparison were the *bakkar*, a bladed harrow giving an initial depth of cultivation of 3-4 inches; the ordinary country plough operating at from 4-5 inches, and some form of inversion plough with which the depths varied between 5 inches and 6½ inches, in most cases being nearer the latter figure.

The soils in which the experiments were conducted were one or other of the heavier black soils which, though not necessarily of the same geological origin, are usually of somewhat similar physical characters, *i.e.*, those associated with heavy loam. In certain cases, the inversion plough was brought into play at the beginning of the hot weather; but in most cases primary cultivation of the plots was done, in as far as preparation for *rabi* was concerned, at the opening of the monsoon. Apart from the difference in the first operation, the rest of the cultivation was the same on all plots, *i.e.*, working with the bladed harrow.

Rabi *experiments.*—The most interesting are those carried out at the College Farm, Nagpur, from the records of which it is possible to study the effect of these implements over a long period of time under manured and unmanured conditions, and under a single crop (wheat) taken year after year. We can also study their effect when wheat was rotated with gram, as in the United Provinces, but under *barani* conditions.

Taking the first of these experiments which covers a period of some 30 years and 26 seasons in which results were recorded, the probable error was in the region of 5·8 per cent.

This period can be examined in several sections :—

-----	Blade harrow I	Country plough II	Inversion plough III
The first five years	100	111	116
The first fifteen years	100	111	113
The last fifteen years	100	103	105
The full period	100	108	110

Wheat was grown continuously. No manure was added. The actual average acre yields, which were of course influenced by the character of the season from year to year, were as follows :—

—	I	II	III
	lbs.	lbs.	lbs.
First five years	589	654	687
Second five years	537	583	612
Third five years	490	544	531
First 15 years	533	594	607
Second 15 years	417	429	440

There was, therefore, a general decline in fertility in evidence in all plots. In the plot of shallowest cultivation the decline was 29 per cent, and in the inversion plot 36 per cent.

It will be noticed that in the first five years while fertility is reasonably good the difference in favour of No. III over No. I is very nearly three times the probable error and that of No. II over No. I twice the probable error. At no time is the difference between the country plough and the inversion plough marked. Though the evidence in the early stages definitely favours No. II and No. III, in the last period there is nothing to show that either of them, in the long run, under conditions of poor or declining fertility, is definitely superior to the bladed harrow.

Examining the results obtained year by year, on 12 occasions No. III was superior to No. I by over three times the probable error and on three occasions it was inferior by a like amount. Of the 12 times 8 occur in the first 15 years; the rest along with the three years in which the practice proved worse, occur in the last 15 years, when fertility had definitely declined. In the case of the country plough, clear superiority to the *bakkar* is in evidence on 8 occasions and clear inferiority on two. These are, however, more spread over the full period of experiment.

In the next experiment recorded, we find that at the end of 15 years of the first experiments half the land under each implement was regularly manured, the rest continuing unmanured to provide the data given above.

Here there is a distinct difference :—

—	Blade harrow I	Country plough II	Inversion plough III
1st period	100	100	120
2nd period—1921-25	100	127	134
3rd period—1926-30	100	133	140
Average	100	125	133

The soil is at the same time increasing in fertility.

	I	II	III
1st period	100	100	100
2nd period	137	150	158
3rd period	150	174	180

It will be noticed that except in the first period, when for unexplained reason the country plough showed no improvement on the bladed harrow, as a whole there is a marked difference well beyond the limit of error in favour of both II and III over I, and a slight but persistent difference in favour of inversion over stirring, though this is not much greater than the probable error. The dominance of the inversion plough over the country plough in the more fertile area of the Gangetic alluvium may, in part, be due to this correlation of fertility with the greater efficiency of the inversion type, whereas, as is shown in the Central Provinces over a long period of farming on land which is rarely manured and is naturally less fertile there is but little to choose between the two in their effect on the yield. As regards the blade harrow, it affords a faster and cheaper type of cultivation.

The third series on the Nagpur Farm is somewhat like the Cawnpore experiment in that wheat is rotated with gram, except that gram appears once in three years instead of every other year.

In this series the country plough does not appear. It is a comparison between the blade harrow, in manured and unmanured condition, and the inversion plough.

In the thirteen years in which wheat appeared the comparative results were :—

—	Blade harrow only	Blade harrow *plus* manuring	Inversion plough only
Over the full period	100	125	138
Over the last 5 years of the full experiment, in which 3 crops were wheat .	100	148	148
Over six seasons of gram . . .	100	127	136
Over the last 5 years, in which two crops were gram	100	120	146

This result is closely alike to that got with manured wheat. Fertility is being maintained by the inclusion of gram and there is a clear benefit from the practice of deeper inversion over shallow primary cultivation. It is doubtful, however, whether inversion alone would have continued to give better results with wheat than would the blade harrow *plus* manure ; in the last three wheat years there is little or no difference between the two treatments.

For some years a twin series was put down, the only difference being that the ploughing of the third plot took place in the early hot weather. Here again inversion was definitely better than the *bakkar*. This series was not continued as observations showed that the improvement caused by inversion in the dry season gave only a very slight advantage over the same work at the opening of the rains, and was thus entirely uneconomic on clean land.

Somewhat similar experiments though not covering such long periods were conducted on the Powarkhera farm, Hoshangabad. In some of these we find the introduction of two ploughings by inversion and country ploughs.

—	Blade harrow I	Country plough once II	Country plough twice June and August III	Inversion plough twice IV
Average of 6 years (per cent) .	100	112	124	124

There is a slightly greater difference in favour of IV over II than at Nagpur. The series, however, did not run long enough and on the whole the difference is not much greater than in the first five years at Nagpur. Judging by III and IV, it is efficient stirring rather than actual inversion which appears to count.

In a parallel series on irrigated wheat the results were

100, 95, 82 and 94 per cent.

A more comprehensive series on two different classes of soils over a longer period of 11 years gave :—

	Soil (*a*)	Soil (*b*)
1. One ploughing, 6—7 in., with Sabul plough in hot weather	124	115
2. One ploughing, 5 in., with inversion plough at opening of monsoon	121	125
3. Two ploughings, 5 in., with inversion plough at opening of monsoon	125	118
4. One ploughing, 5 in., with country plough at opening of monsoon	111	103
5 Two ploughings, 5 in., with country plough at opening of monsoon	116	120
6. Cultivation 3—4 in. by blade harrow at opening of monsoon	100	100
7. One ploughing, 7 in. with Sabul plough at opening of rains	109	116
Probable error .	5·47 per cent	9·3 per cent

These trials were on unirrigated wheat. The general body of this evidence, though not conclusive in view of the considerable probable error, favours inversion at 5 in., whether single or double, to simply stirring as on 4 and 5. The results on the whole in comparison with the blade harrow, and *inter se* conform to the results of the earlier experiment noted above. Though slightly more favourable they are not materially different from those secured at Nagpur on unmanured wheat in the early years of such practice.

An analysis of the results of individual years, however, shows that, at any rate in dry cropping, the advantage or otherwise of these practices over the blade harrow is closely related to the season's rainfall.

Treatments	1	2	3	4	5	6	7	
1925-26 .	163	139	142	137	131	100	135	Poor rain
1926-27 .	107	121	107	105	107	100	103	Average rain
1927-28 .	103	106	108	109	121	100	114	Heavy rain
1928-29 .	96	101	112	83	107	100	95	Average rain
1929-30 .	117	138	136	120	140	100	135	Poor rain

Average result of both series

In years of average or heavy rain there was no appreciable gain over the blade harrow, while in years of short rainfall a distinct advantage followed either form of deeper working, being slightly in favour of inversion. This relationship of the amount of the rainfall to the probable results is supported by a comparison of the results got at Akola (Berar) with a monsoon rainfall of 20—25 in. and Labhandi (Chattisgarh) with a rainfall of 45-55 in. Both results are the average of 10 years' experiment.

—	Wheat crop manured	Wheat crop manured	Wheat crop unmanured
	Akola (Berar)	Labhandi	Labhandi
Blade harrow (3-4 in.)	100	100	100
Country plough (5 in.)	116	101	101
Inversion plough (6½ in.)	131	111	101

There is a marked advantage in Berar and practically speaking none in Chattisgarh apart from some advantage when the land is fertile. It may be noted that

over about the same length of time the experiment at Nagpur, which takes an intermediate position as regards rainfall, shows an intermediate gain by deeper work.

Kharif experiments.—In as far as the influence of deeper cultivation in the preparation for *kharif* crops is concerned, there has not been so much work, but such as there is does not tend to indicate that greater depth than can be secured by a blade harrow—say 4 in.—is in the least necessary in ordinary practice, under conditions when the eradication of perennial weeds is not a dominant factor.

In experiments at Nagpur, except in one instance in which the process of inversion tended to throw the land into a series of ridges sloping down on either side towards an open furrow, the general trend of evidence was against increased depth. In the exceptional case just quoted, in which over a period of 11 years (6 under cotton and 5 under *juar*) there was an increase in cotton on the regularly inverted land, the reason is probably associated with the improvement of the drainage of the plots so treated.

Blade harrow (unmanured)	Blade harrow (manured)	Inversion (unmanured)
100	122	120

It is, however, cheaper to practise No. 2 rather than No. 3 on account of the cost of such work in the dry season.

The results secured at Akola on cotton tally, on the whole, with the general results at Nagpur if the land is kept flat.

Blade harrow	Country plough	Inversion plough
100	107	99

The above is the average over a period of 10 years. An examination of individual years showed that the results were influenced chiefly by two factors :

(*a*) the arrival of early showers, which permitted the ploughed land to be worked down for early sowing,

(*b*) the quantity and distribution of the rainfall in the early weeks of the main monsoon.

If the early showers were absent, thus delaying seed bed preparation and timely sowing, or if the main monsoon were heavy or persistent, the trend of results was strongly against depth in primary soil working.

Another factor, which was obvious in work at Nagpur and which frequently reacted in the early stages against success from inversion unless a long period of weathering had intervened between initial ploughing and the actual preparation of the land for sowing, was the defective character of the final seed-bed. When the seed-bed is prepared by means of the *bakkar* only, the soil below the bakkared zone remains open and cloddy, with the result that although cotton germinates well it tends to die off in the early stage of growth. This does not happen with *juar*, which is sown later than cotton, as sowing need not be done until the monsoon has broken down and compacted the layer of soil underneath the bakkared zone. If periodic inversion is practised for early-sown crops, it is essential to give intermediate cultivations between inversion and final bakkaring, either with the country plough or with some type of modern cultivating implement. The other alternative is to use the inversion plough only in years when a late-sown crop, like *juar*, is to be grown.

Tillage in the Bombay Presidency

A number of tillage experiments have been in operation in different parts of the Bombay Presidency in the course of the past thirty years. They were conducted under varying soil and climatic conditions. The majority were put down in the early stages of departmental activity. Unlike the Central Provinces, they have been carried out almost entirely on *kharif* crops—cotton and *juar*. It is not easy to get more than an indication of effects, as few have been even duplicated and none have been carried on for a sufficiently long time to neutralise, in part, the probably definite error which was likely to have been present in the plots themselves, and the effect of the variations from year to year in the climatic conditions under which the crop was growing.

On the farm at Poona which is in a relatively dry tract and where the soil is less heavy than at other centres and probably in a condition of relatively high fertility, a three-year experiment with *juar* and cotton in which the iron inversion plough was compared with the country plough, shows that the cost of doing the work by the former to secure the same depth was Rs. 3 per acre less and the average return from both *juar* and cotton slightly higher. The relative improvement in net profit was stated to be 16 per cent in the former and about 8 per cent in the latter crop.

In the North Central Division, another area of relatively low rainfall but heavier type of soil in which an experiment ran for 5 years and in which cotton and *juar* were rotated, the cultivation for the former being either inversion or shallow ploughing with the country plough, the general conclusion arrived at was

that whereas, in a bad growing year in which the rain was deficient, ploughing with an iron plough gave some indication of beneficial results, the reverse was the case in a good season. From an economic standpoint, taking into consideration the higher cost of the deep work in the dry season and its problematical success, no advantage could be definitely claimed for deeper cultivation preparatory to cotton. In this series the main advantage of such work appeared in the second crop of the rotation, *i.e.*, *juar*, in which a definitely higher yield followed inversion in the previous year. The average profit over the rotation thus favoured deeper work preparatory to cotton to the extent of approximately Rs. 5 per acre.

An experiment has been carried out at Dharwar, an area in which cotton is sown at a much later date than elsewhere, *viz.*, the middle of August, and where the rain continues well into the cold season. The experiment is of short duration and hence somewhat inconclusive; there was a 13 per cent increase in cotton when the land had been inverted early in the season but a loss in *juar* on land thus treated.

On the heavy soils of Gujarat, two experiments, one over a period of 5 years and another for two years on duplicated plots, showed that on the average there was nothing to recommend deep cultivation with the inversion plough as better practice than, in this case, soil-paring with the blade harrow. It may be noted here that the necessity of doing such ploughing soon after the removal of the last crop and not waiting till nearer the monsoon, is mentioned as a factor helping the efficiency of deeper work, a detail which was also in evidence in like cultivation in the Central Provinces. The results of these trials are recorded below :—

Average of 5 years

Crop	Treatment	Market product	Fodder	Cost	Value	Net profit
		lbs.	lbs.	Rs.	Rs.	Rs.
		No. 1				
Juar .	deep .	824	2,585	17·1	47·10	30·9
Juar .	shallow .	806	2,418	15·14	45·4	29·6
Cotton .	deep .	341	..	11·8	45·8	34·0
Cotton .	shallow .	372	..	10·9	51·2	40·9
		No. 2				
Juar .	deep .	879	1,752	Average of 2 years in duplicate		
Juar .	shallow .	835	1,631			
Cotton .	deep .	358				
Cotton .	shallow .	346				

The small difference in cost between deep and shallow work per acre given in the first experiment is exceptional. The corresponding figures are not recorded in experiment No. 2 though in the text of the report it is stated as being Rs. 15 per acre more, which is consistent with costs at Nagpur on heavy soil of this type, when such work has been done in the dry season.

In as far as these field experiments go, apart from the Poona experiment on a rather lighter and drier soil of more than average fertility, it can be said that there is no clear evidence in favour of annual deep working of the soil as accomplished by the inversion plough.

The only long-term experiment, of a kind, is that recorded at the Surat Farm where three fields have been under the following farming systems from 1913-14 to 1930-31 :—

Field (A) a good cultivator who ploughs with the country plough after the arrival of the rains and applies 18 loads of farmyard manure to his cotton once in 6 years and uses the rotation—cotton, *juar*, cotton, *juar*, cotton, and *tur* with sesamum.

Field (B) an ordinary cultivator who only uses the blade harrow and applies nine loads every sixth year, growing cotton and *juar* in rotation with no pulse crop in the sixth year.

Field (C) a cultivator who ploughs deep and inverts once in six years after *juar*, and applies 18 loads of manure with the rotation as in A.

	Cotton			*Juar*			*Til*	*Tur*	*Til*	*Tur*
——	A	B	C	A	B	C	A	C	A	C
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
	Average yield per acre per annum in lbs.									
Period 1 (1914-15 to 1921-22)	417	402	439	grain 644	grain 603	grain 700	125	146	136	149
				fodder 1537	1452	1808				
	Return per acre per rotation									
	1251 103 per cent	1206 100 per cent	1317 109 per cent	1288	1809	1400	125	146	136	149
				fodder 3974	4356	3618				

	Cotton			*Juar*			*Til*	*Tur*	*Til*	*Tur*
	A	B	C	A	B	C	A	C	A	C
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
	Average yield per acre per annum in lbs.									
Period 2 (1922-23 to 1930-31)	486	449	569	grain 767	grain 626	grain 852	206	90	203	105
				fodder 1564	1361	1861				
	Return per acre per rotation									
	1458	1347	1707	1534	1878	1704	206	90	203	105
	108 per cent	100 per cent	127 per cent							
				fodder 3128	4083	3722				

The average profit per acre per annum was :—

—	A	B	C
	Rs. A. P.	Rs. A. P.	Rs. A. P.
In period 1	22 2 3	22 8 0	24 3 5
In period 2	14 5 3	13 15 0	25 2 5

It will be noticed that A and C differ only in the fact that C inverts his land once in six years ; otherwise the cultivation, rotation and manuring are alike. Comparing A and B, A uses more manure, he introduces a third mixed crop bringing a deep-rooted legume into the rotation, and he uses a country plough as opposed to a blade harrow.

On the evidence we can fairly safely conclude that, if black soil is clean, increased manure, an alteration in cropping, and the use of the country plough do not effect anything equivalent to the extra cost involved. It would appear, however, that C who periodically introduces complete inversion to about 7 in. or 8 in. gets an increase with, apparently, a slightly improved return. This is not, however, very marked in the first period when the plantings were equally spaced; such as there is, is probably the outcome of the interaction of inversion and effective manuring. In the second period A and B continued with the original spacing while C, though maintaining the difference in ploughing adopted a much wider spacing between the crop. This has rather upset the experiment as a direct evidence of the influence of simple pre-sowing tillage differences on the outturn. The Bombay Department of Agriculture are inclined to attribute the marked increase by C in the later period solely to better inter-tillage and wider spacing and to conclude that inversion of even a periodic character is not essential on clean black cotton soil. This is possibly correct, though the writer, on his own experience on heavy soils, is inclined to give some of the credit of the total increase to the periodic increased depth and inversion factor.

Tillage in the Madras Presidency

Some interesting data are also available in the Madras Presidency. Here, as in Bombay, the field crops under such work have been cotton and millets. The experiments include all three types of primary soil handling. The results obtained, possibly as the outcome of difference in soil or climatic conditions at the several experimental stations, are somewhat contradictory. The older experiments were possibly not continued long enough. Those at present in operation have been for the most part well replicated and it is to be hoped that they will be kept going for a number of years, as the important thing is not to establish the fact that deeper work, or inversion as the case may be, results in a better immediate return but to establish what the outcome would be if such operations became the year-in and year-out practice under the farming conditions of the ordinary cultivator.

At Guntur, an experiment conducted for five years in which the country, Monsoon, Victory, and Sabul ploughs provided the initial cultivation, roughly working to depths of 5 , 6, 7 and 8 in. respectively, the last three inverting the soil, gave averages in seed cotton of 499, 498, 520, and 496 lbs. per acre. The year to year results are closely alike, with, as in Bombay results, a more definite advantage in a year of light monsoon. The grain yields of millet average 534, 566, 584, and 576 lbs. per acre, during this period. There is thus no advantage on yield from deeper preparatory working for cotton and such gain as appears in millets is well within the margin of error.

At Koilpatti, one experiment replicated five times compares the Monsoon plough and the blade harrow or Guntaka (the *bakkar* of the Central Provinces and

Bombay). The average yield of seed cotton per plot of these two implements are 44·2, and 44·4 lbs., *i.e.*, as 100 : 100·5. When used in prior cultivation for fodder millets, the returns are as 88 : 100, the blade harrow and its shallower work being the better. In another experiment now in progress, in which cotton and millets are in rotation, the Guntaka and Monsoon plough provide the initial cultivation. The average yield of cotton per acre with the shallow working Guntaka is 520 lbs., while with the Monsoon plough it is 483 lbs.

Against these results, we have to set, however, the evidence of two experiments on heavy black cotton soils—one at Koilpatti in earlier years replicated three times, and another which has been in progress for the past seven years at Hagari. In both these the inversion practised is of a definitely deep character, *viz.*, 9—10 in.

In the former we have the following results:—

	Comparative average returns COTTON
1. Ploughed deep annually	181
2. Ploughed deep every 4th year	120
3. Country plough each year	100

In the latter the comparative average returns were as follows:—

Character of inversion	Cotton	*Juar*	
		Grain	Straw
1. Guntaka (shallow-paring)	100	100	100
2. Inversion ploughed deep once in 5 years .	106·5	126	112
3. Inversion ploughed deep once in 4 years .	109·6	118	106
4. Inversion ploughed deep once in 3 years .	105·6	106	99
5. Inversion ploughed deep once in 2 years .	111·9	123	108
6. Inversion ploughed deep annually . .	110·4	119	105

There is no evidence as to the length of time the first experiment was continued, and though it was replicated while in progress, a short period of operation would not have provided fully reliable data. The additional yields achieved in

the second experiment are in all probability within the margin of probable error and are not conclusive evidence of the advantage of such deeper work. The amount of difference in cotton is but small while, like results secured in Bombay, they are slightly better in *juar*. When cost is taken into consideration, there is economic loss in every treatment in which deep inversion plays a part, except in the case of treatment No. 2 where on the two crops there is a few annas in favour of ploughing once in five years over continual use of the blade harrow. The experiment would have to go on for 20 years at least to get fully reliable data. In both these experiments, however, there is definitely no financial gain from frequent resort to deep working.

The above results in Madras are, on the whole, closely comparable with those obtained in the Central Provinces and Bombay, indicating little or no advance in yield, even at times the reverse, and no economic gain by the use of implements of type No. 1 over those of types Nos. 2 and 3 in the ordinary routine cultivation of the commoner *kharif* staples grown under natural rainfall.

Drainage as a factor influencing results

In working heavy soils for cotton and *juar* under monsoon conditions, the importance of creating, by cultivation, an improvement in drainage was indicated in the Central Provinces experiments in which the increased yield secured in at least one experiment from annual inversion, was attributed to the way the levels were left by annually ploughing round a central ridge. An experiment in Gujarat on rather different lines but with the provision of drainage as its chief feature reflects like results. In this case the soil, after adequate cultivation, was ridged up to provide ridges 14 in. high, 18 in. wide and 5 ft. apart from centre to centre. The furrows were wide enough apart to permit of deep intercultural operations using a plough in the bottom of the open furrows.

	Average yield of seed cotton	Per cent increase	Average yield of *juar*		Per cent increase	
			Grain	Fodder	Grain	Fodder
	lbs.		lbs.		lbs.	
Flat cultivation with usual inter-tillage	503	.	828	1,633	..	..
Ridged with shallow inter-tillage	579	15	914	1,606	11	7
Ridged with deep inter-tillage	617	23	1,019	1,794	23	10

Factors which react against success in deeper inversion work in monsoon-sown crops

Deeper cultivation, especially as this for the most part implies inversion, is a matter calling for a certain amount of thought and consideration on clean lands. It is certainly not a practice which can be freely advocated as certain to increase yields in the ordinarily staple *kharif* crops of India let alone economic returns. The evidence furnished by the Bombay and Madras experiments in general closely tallies with that available in the Central Provinces on like soils. The reasons against its regular use in the preparation for a crop like cotton are :

(*a*) expense,

(*b*) delay in sowing—a matter of very pronounced importance in its effect on yields of crops, like cotton, which are sown on the arrival of the monsoon, with the expectation of heavy or continuous rain once it has settled in,

(*c*) the chances of securing either an uneven seed bed, or one which holds too much moisture round the young plant.

It would, however, appear to be a safer practice if done immediately after the removal of the last crop, thus giving weathering and cross cultivation more opportunity to break down the clods and create a bed in advance of the heavier rains. A disc plough, if available, is a good means of securing a suitable seed bed, while any early cross cultivation, whether by the use of Indian ploughs or a 'cultivator' should work well down towards the base of the plough slice. In wetter tracts, if annual inversion is attempted, a system of ploughing which tends to create the ridge and open furrow contour of the old English clay lands, or a subsequent lay out, on heavy soils, of the type adopted, in the Gujarat experiment, will certainly help in making ploughing more advantageous than would appear to be the case from experimental work in which the details necessary to bring out the full effect have not always been in evidence. Where soils are a little lighter, though still loams, and where the rainfall is less, there is probably more chance of getting effective results than where the reverse is the case.

Generally, *i.e.*, in cultivators' conditions, it would appear that in the preparation for the rain-sown field crops, shallow cultivation up to 4—4½ in. with a periodic resort to deeper work is usually the safer proposition. The experiments at Dhulia (Bombay) indicate the advantage on the rotation as a whole, if not on the crop for which inversion was done, while the long-period comparison of systems of farming at Surat appear to show that such periodic inversion reacts, even if not very markedly, when the field is given a substantial periodic addition of heavy manure. The writer, after a number of years of experiment and observation in fields growing *kharif* crops annually, adhering to the practice outlined above, decided on a rotation in which deeper inversion was included once in five years, partly as a means of improving rotational returns and partly as insuring against the establishment of

perennial weeds like *kans*, *kunda* and *dub*. Apart from the value of deeper periodic inversion of this kind, there is no real evidence in support of any belief that deeper cultivation or steady inversion is essential in the securing of the best economic returns on field crops like cotton, *juar*, *bajra*, *tur*, and the like. Good country practice, whether secured by the blade harrow or the country plough according to location, and which stirs from 3½ to 4½ in. of soil, is in general sufficient, if accompanied at fairly long intervals by deeper work. For this purpose, a modern, iron, inversion plough of sufficient weight to balance the soil resistance to its forward progress under given conditions of soil and dryness, affords a useful and economic unit, provided that it handles at least 8 acres per annum. The most important factors in attaining better yields on lands clear of perennial weeds are light additions of farmyard manure, at the rate of 2½—5 tons, applied if possible every third year, and a sufficient spacing between the lines to allow of ready inter-cultivation by bullock-drawn hoes.

Inversion ploughing almost an essential in dealing with established perennial weeds

It is only when the worse types of common perennials as *kans* grass (*Saccharum spontaneum*), *kunda* (*Ischoemum pilosum*) and *dub* (*Cynodon Dactylon*) are established on black cotton or heavy soils that the question of dry-season deep soil inversion becomes imperative. Certainly, in as far as their removal becomes the main feature governing cultivation practice, no class of ploughing except that of inversion to depths varying with the position of the rhizomes or main roots, as the case may be, and the exposure of the upturned clods to the desiccating action of the sun is really effective. This is particularly the case with the first two and, in certain distributions in the soil, with the third, though at times *dub* on lighter soils, like another common perennial pest *nagarmotha* (*Cyprus scariosus*) can be got under, weather permitting, by frequent and persistent work with the blade harrow—a process of starving the underground portions by cutting off the surface portions as soon as they appear.

Inversion and deeper working as economic practice for garden crops

Whatever doubts may exist regarding the advantages of inversion and deeper work as a regular practice in the primary preparation of the soil for ordinary rain-sown crops, or at times for those sown after the rains, there does not appear to be any doubt as to their efficiency in adding to yields, and certainly to net profits, when it becomes a matter of primary cultivation for crops of higher monetary value such as sugarcane, potato, tobacco, and what are termed "garden crops" all of which, it may be noted, are much more heavily manured than the more ordinary staples, and are almost invariably irrigated as necessity demands.

An experiment with potatoes in the Bombay Presidency in which the only difference lay in inversion to a fair depth as against the preparation of the soil by

the country plough only, shows a clear gain in yield from 16 per cent to 19 per cent of sound potatoes, and a net increase in profit from Rs. 51 to Rs. 68 per acre according to market prices. Like satisfactory results are also on record on experimental farms all over India in the case of tobacco, sugarcane, turmeric, ginger, and crops of a semi-garden type, as the outcome of deeper soil working by the reduction secured in the cost of preparatory work, especially when considerable areas have to be got ready, and by the better working in of heavy manures like green manure, which, at any rate in the United Provinces, is becoming a fairly common practice in the preparation for the planting of sugarcane.

In working soil to a specified depth consistent with the best interests of any particular crop under like conditions of soil, there is no doubt that an iron inversion plough is distinctly cheaper. The work is more uniform and the speed is greater, hence the cost per acre measured in man and bullock power days is lower. Actually, the final effect as measured by the finished seed bed need not be remarkably different; but the achievement of this similarity in the depth and quality of the prepared bed will have called for a good deal more tillage if secured by the country plough only. The fact that this is the case naturally tends, except among the highest standard of cultivators, to a lesser depth, when the country plough only is used, and hence not infrequently a seed bed is shallower than is desirable even if not defective in other characters.

It is clearly indicated in the Central Provinces experiments on wheat that increased depth, and still more so, increased depth with inversion, reacts with much greater effect when the fertility of the soil is being maintained or raised by other factors. It is reasonable to presume that the same holds good for "garden crops", even when that term is extended to intensively-farmed field crops. In other words, deep working and inversion are able to exert their maximum influence on yield only when associated with heavy manuring and high fertility. Inversion and deeper working lead, as in the case of wheat, to a better utilization of plant food. Successful deeper work with inversion ploughs can only be secured and maintained when adequate attention is being given to manuring, or if the fertility of the field is reasonably high. The experiments at Cawnpore gave a very definite vote in favour of inversion. In this case the factor of depth was eliminated by irrigation, but relatively to other areas in India the Gangetic alluvium is more fertile. Further, the fertility of the farm had been added to by past treatments and maintained by the regular inclusion of gram in the rotation. The results favoured inversion as they did in the Central Provinces on a like crop on fertile land, and as they do anywhere on garden crops, provided adequate manuring is given. Soil inversion and fertility go hand in hand; without the latter the former is likely to be ineffective and without the former the fullest returns from the latter are unlikely.

General summary

Summarising the experience gained in India :—

1. When it is a matter of tackling established perennial weeds which can only be dealt with in the dry season, and by work to a depth of at least 6 in. to 10 in., ploughs of type No. I of sufficient weight to balance the resistance of the soil and with sufficient suction are both more effective and cheaper to operate.

Implements of type No. III can not penetrate and are unsuited for actual eradication though, under suitable conditions, their frequent use may reduce weeds (like *nagarmotha* (*Cyprus scariosus*) and *dub* grass (*Cynodon Dactylon*)) by a process of starvation. Such weeds can be checked by implements of No. II type but eradication in any heavily infested field is far from satisfactory and the high cost and labour entailed react against their usefulness.

2. In the preparation of land for "garden crops", which, in general require deeper and fuller cultivation, the paring type of primary cultivation is not sufficient. Either type No. I or No. II has to be resorted to. The first is cheaper to operate, given a sufficiency of land for its utilisation and, as depth is easier to attain with it, is more efficient than the second. Adequate manuring however is required. For this reason, and also because it is necessary to provide a sufficient area if an inverting plough is to be an economic proposition, an implement of this type is more likely to give its best returns in the hands of a well-to-do farmer. In the main, at least in the Gangetic alluvial soils, a similar position in depth and quality of tilth can be secured by the Indian plough but with greater labour. There appears, however, to be some direct advantage from inversion on the irrigated soils which makes this practice not merely a cheaper way of securing a specified soil condition, but also a means of increasing yields under manured conditions to a greater degree than is perhaps the case in the south, west and centre of the country.

3. With regard to primary cultivation for the ordinary *kharif* and monsoon-sown staple crops, which depend on rain for their moisture, provided that perennial weeds have not to be reckoned with, there is no evidence to show that regular inversion or greater depths than those which can be secured by good work with a paring implement, or in other areas by a light country plough, add appreciably to yield. In most cases, the employment of an inversion plough in the dry season for this purpose adds considerably to costs and such practice, even if it does raise the yield, is rarely economic on clean land. At the most, on the class of soils usually carrying crops like cotton, deep cultivation should only be periodic at intervals of four to six years. The heavier the soil and the wetter the area, the less likely is it that deeper work than that found in common practice, *viz.*, $3\frac{1}{2}$ in. to $4\frac{1}{2}$ in, will be effective. In general such periodic deep ploughing should be done as soon after the removal of the last crop as possible, and unless the

following crop can be sown after a substantial fall of rain has taken place, it is advisable to use some toothed implement across the line of ploughing before the blade harrow is employed to complete the seed-bed preparation.

The only condition in which deeper work at more frequent intervals may be desirable is on definitely sloping fields of the lighter grades of black cotton soil, in areas where the total rainfall is not high—under 30 in.—but where the precipitation of rain in individual falls is heavy. Such ploughing should be at right angles to the slope. Cultivation of this kind reduced erosion more effectively than do either of the other forms.

In conditions such as obtain in the canal areas of the Gangetic alluvium and possibly the Punjab where cotton and other *kharif* crops are sown well in advance of the monsoon under irrigation, the position is probably similar to that detailed earlier for wheat in the United Provinces, and inversion to 4—5 in. depth is likely to be effective and economic provided fertility is maintained.

4. In as far as cold weather and post-monsoon-sown crops are concerned, all three types of tillage are applicable. Unless, however, the fertility is good and is adequately maintained either by additions of farmyard manure or frequent inclusion of leguminous crops in the rotation, deeper work and inversion are not likely in the long run to be worth while. Where fertility is high, there is some indication that inversion to a depth of 5 to 6 in., under conditions where the crop is largely dependent on monsoon precipitation, is a sound practice. This is most marked in zones where the rainfall during the monsoon is under 30 in.

Where the general fertility level is low and the cultivator is unable to raise it, deep work and inversion have only a temporary effect in increasing yields which are unlikely to be maintained, while the net profit secured is on the average too low to be attractive. Under *barani* conditions and those obtaining in the Central Provinces, depth increases, such as are securable over paring by either the inversion or the soil-stirring plough, appear on the whole more important than actual inversion, while under irrigated conditions as in the Gangetic alluvium, inversion appears more important than depth, causing light iron inversion ploughs to be of more definite value.

The influence of "duty" on the possibility of the effective introduction of inversion ploughs

In connection with any propaganda directed towards the introduction of an inversion iron plough into the Indian practice and the partial displacement, thereby, of the local country plough or paring plough hitherto utilised for primary work, it must be borne in mind that in a great many cases in this country, it is not merely a matter of whether the yield per acre is increased, or even a matter of increased net profit per acre on the experimental plot by the use of a plough of this type. There is also the question whether or not the individual farmer can get

enough use out of a specialised implement of this kind to pay for its depreciation, interest and maintenance costs. In a very large number of cases the individual holdings are small. The farmer's country implements have an effective duty as, being used for almost every operation in which he engages, the acreage covered per annum is reasonable, even though the farm itself is small. This cannot always be claimed in the case of an inversion plough which is not likely to be used more than once or, at most twice over any individual acre. Thus to make it a safe investment, four conditions are wanted :—

(*a*) A certainty of increased yields.

(*b*) A definite saving of time or labour as compared with the local implement in effecting the same standard of perfection—a factor of rather less importance on a small holding where the cultivator has usually plenty of time for his farm work and little scope for other employment.

(*c*) A sufficiency of area relative to the cost of implement.

(*d*) As low a capital cost as is consistent with efficiency and a fair rate of depreciation.

Except on the larger farms where labour may cost money and time is important, one must be fully satisfied that the introduced implement is going to add appreciably to the yield and financial return per acre of the crop on which it will be utilised. The amount which it must add if it is to be worth pressing as a permanent addition to the farmer's capital goods is governed by its cost and the area over which it will be worked in the course of the year.

Take, for example, the simple case of a farm under equal areas of wheat and gram in rotation and assume that wheat is worth Rs. 2-12-0 per maund to the grower and gram Rs. 2-4-0. Under fertile soil conditions in the Gangetic valley, with this rotation, given irrigation, we may expect under ordinary 4—5 in. tillage with the country plough 1000 lbs. of wheat and 800 lbs. gram per acre. Accepting the increases at Cawnpore of 30 per cent for wheat and 9 per cent for gram by the use of a heavier Punjab plough working 6—7 in. deep, and 23 per cent and 5 per cent by using a Meston at a depth of 4—5 in., we have in the former a gain of 300 lbs. wheat worth Rs. 10-5-0 and 72 lbs. gram worth Rs. 2, a total of Rs. 12-5-0 on two acres. The plough will cost about Rs. 20 and depreciation, interest and repair charges can be placed at Rs. 6 per annum.

In the latter case the increase in yields will be 230 lbs. and 40 lbs., and the gross value on two acres Rs. 9. The plough in this case costs Rs. 6, equivalent to an annual cost of Rs. 2.

On a ten-acre holding the first plough would be expected to give a gross increase worth Rs. 61-9-0 less Rs. 6, *i e.*, Rs. 55-9-0, and the second Rs. 45 less Rs. 2 *i.e.*, Rs. 43.

The bigger plough is the better investment, assuming that the owner has a good pair of bullocks. On a two-acre holding cropped like the above, the first plough would give Rs. 12-5-0 less Rs. 6, *i.e.*, Rs. 6-5-0 increased revenue ; while the smaller one by giving Rs. 9 less Rs. 2, *i.e.*, Rs. 7 would be the better implement. As the yield is definitely increased, either plough pays even on a relatively small holding.

Turning to the Central Provinces, when farming dry land of a stiff character but in a fair state of fertility, the standard yield may be placed at 600 lbs. for wheat and 500 lbs. for gram. Using a heavy plough to reach 6—7 in., in this case costing Rs. 40, the average increase may be put at 25 per cent, and 15 per cent, *i.e.*, 150 lbs. and 75 lbs. respectively, giving a gross increased return of Rs. 7-4-0 per acre. With a lighter plough of the inversion type costing about Rs. 20 on like land, we might get 20 per cent and 12 per cent increases, *i.e.*, on the above standard an increase of 120 lbs. and 60 lbs. on the two crops, worth together Rs. 5-12-0. The depreciation and other charges on these ploughs may be put at Rs. 10 and Rs. 6, respectively.

On a ten-acre block, the first plough would give the owner a net increase of Rs. 26-4-0 and the second Rs. 22-12-0 , while, if applied on a two-acre holding, the first plough would result in an annual loss of Rs. 2-12-0 and the latter would, practically speaking, leave the owner where he was when in possession of a blade harrow. The lighter plough might be advised on any area of three acres and over and, with allowances for failure, a minimum of four acres would be desirable in plough No. I.

Where, under like conditions of cropping, the soil fertility is low, the standards would be about 500 and 450 lbs., and the probable increase in the neighbourhood of 12 per cent and 10 per cent, *viz.*, 60 lbs. and 45 lbs. making the probable addition to the return on two acres about Rs. 3-4-0. A ten-acre holding would give a net gain of Rs. 6 when using the bigger plough and Rs. 10 on the lighter one. It would, in this case, require at least a six-acre holding to enable the first plough to cover its cost and a minimum of four acres for the latter.

In dealing with crops like potato, in which a 16—20 per cent increase is achieved by substitution of a modern inversion plough, with a net gain per acre of Rs. 45 —50, the cost of the plough and the area factor play much smaller parts.

From the above it is obvious that, apart from increase arising from the interplay of fertility and inversion, the greater returns to be secured under garden crops and staples on fertile soil render the wider utilisation of such implements more feasible in those conditions than is the case with crops of low monetary value, or when the land is of poor quality whether from lack of plant food or insufficiency of water.

CONCLUSIONS

So far as the soils of Madras, Bombay and Central Provinces are concerned, and with these we may include the soils of considerable portions of Bundelkhand and Central India, there appears to be no marked assurance that the inversion ploughs have any particular advantage either in their effect on yield or, even more definitely so, on profits over a good type of paring plough or over the country plough, except in the matter of eradicating perennial weeds, or in the preparation of the soil for "garden crops", in particular sugarcane, tubers and root crops. Where the soil is light, deep work is rarely advisable anywhere Where the soil is on the heavy side, in general unirrigated, and where *kharif* staples are concerned, increased depth and inversion show but little advantage in crop yield, cost considerably more, and being done under dry-season conditions, demand heavier and more costly ploughs than the average small farmer can employ to full advantage. For these soils, so far as such crops are concerned, periodic inversion coupled with increased depth is the best which can be suggested. Better yields and a better return on capital investment are more likely to be secured by substituting for the extra cost of deeper work light dressings of organic manure Propaganda to stimulate the making of compost and its utilisation in light dressings of 2½-3 tons per acre, possibly coupled when economic conditions permit with light dressings of ammonium sulphate, is much more likely to result in increased yield and increased profit than propaganda directed to replacing the present forms of tillage by deeper inversion.

In these same areas, in the main the more northern portions, where *rabi* crops like wheat are grown and are for the most part unirrigated, there appears to be more evidence in favour of the replacement of the paring plough, where used, by something capable of deeper work—either an implement operating on the lines of the country plough, or an inversion plough capable of 5—6 in. depth when worked during the rains. Here the necessity of attention to soil fertility is important if either of these forms, and in particular the second, is to give the fullest advantage. There appear to be little to support propaganda in favour of inversion as a means to an end on the smaller grades of holdings on poor-quality land.

When we turn to the Gangetic alluvium and probably to the irrigated tracts of the Punjab, (though for the latter the writer has no direct evidence,) the outlook is different The advantage of inversion, whether accompanied by greater depth or not, holds here as in other parts of India in as far as the more valuable and usually manured crops are concerned. In addition the soil, on the average is of a higher grade of fertility than in the Central Provinces and considerable areas of Bombay, is easier to provide with water (either by means of canals or low-lift wells), and does not call for anything like so expensive a form of inversion plough. For these reasons the common implement of tillage is of type No. 2 rather than type No. 3, and inversion ploughs have far greater possiblities as aids to improved returns.

In the conditions prevailing in this tract, inversion is a more important factor than depth. For this reason though the heavier types of plough, *e. g.*, the " Punjab ", are probably the best where holdings are of a fair size and where the general standard of farming is good, lighter types like the " Meston " are of very definite value in point of increased yield and lower working costs, while their low price (Rs. 5-8-0 to Rs. 6-0-0) make them certainly economic additions to any holding of three acres and upwards, thus giving them a much wider range of application. In advocating their wider use, however, the importance of propaganda directed to increasing manure supplies must not be overlooked. In this tract, as elsewhere, the best returns from the use of this type of primary tillage is undoubtedly linked with the maintenance of a good level of fertility. The higher the natural fertility and the better the standard of farming in this respect, the safer and the more effective becomes the introduction of the inversion plough and its substitution in place of the indigenous type

VITAMIN—A ASSAY OF GHEE

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Ghee or milk fat is the principal source of vitamin A for the majority of Indians. A small amount is obtained from carotinoid foods and green (salad) vegetables. The germs of the cereals are generally lost from the food in the course of preparation from the grain. The supply of ghee is far short of the demand ; as a consequence adulteration is largely practised. The use of hydrogenated oils and fats for adulteration or as ghee substitute is extensive and amounts to millions of rupees.

Methods and data are available for testing the purity of ghee by analytical chemists or chemical examiners. This work is an additional plea to include vitagraphic assay for vitmin A in ghee or butter. The value of ghee lies in its growth-promoting factor and not the volatile fatty acids or certain glycerides. Well-trained chemists and technologists are employed in oil-refineries and hydrogenation factories, so that the articificial product approaches very nearly to the chemical and physical properties of the natural products. However, if the vitamin content be determined and the ghee valued on its strength, then a real service will be done to the consumers. This estimation is now possible for routine or research work in a number of ways, chemical or physical, as distinct from biological, so that a vitagraphic assay of ghee is easy and simple. Vitamin A can be estimated in the following ways.—

(1) Biological value, resumption of growth in rats deprived of vitamin A reserve by deficient feeding. (2) Blue value, action of antimony trichloride on the fat or oil, and the Lovibond tintometric value. (3) Blue value, action of antimony trichloride on the unsaponifiable matter of the oil, and the Lovibond tintometric value. (4) Blue absorption value on the oil at 608 and 578 mμ (5) Absorption value, at 328 mμ on the oil spectrophotometrically. The biological methods are tedious and expensive. It takes long time to perform and is not suitable as a routine test. The variation due to rats, errors of the method, and the time required for an assay renders it unsuitable as a method for the analysis of ghee. [Sherman and Munshell, 1925 ; Sherman and Bertis, 1928 ;

Coward, 1932 ; Coward *et al.*, 1930-31]. The blue test for vitamin A has been extensively studied and used in biochemical research and routine work. The test depends on many factors, and they must be strictly observed in the case of ghee to get concordant and trustworthy values. [British Pharmacopœia, 1932; Morgan, 1932 ; Heilborn *et al.*, 1931., Bacharach and Smith, 1934 ; Evers, 1934]. It may be necessary to concentrate the vitamin for a better estimation in ghee before performing the test as also to eliminate substances that inhibit or interfere with the colour reaction. Interfering substances can be distinguished as they differ in shade and stability and do not show bands at 608 and 578 mμ characteristic of vitamin A. [Brodie *et al.*, 1931 ; Coward *et al.*, 1931 ; Smith and Hazley, 1932 ; Corbett *et al.*, 1933 ; Crews and Cox, 1934]. Carotin and zanthophyl that are present in butter and ghee can be estimated and allowed for in vitamin A assay. Alternatively, since carotin gives rise to vitamin A in biological digestion and occurs only to the extent of 10 to 25 per cent of total vitamin A in butter fat, it need not be estimated separately. [Moore, 1930 ; Capper, 1930 ; Capper *et al.*, 1931 ; Lundberg, 1931 ; Baumann and Steenbock, 1933]. Ultra-violet absorption at 328 mμ is a quick and useful method, and has been applied by a large number of workers. It is more accurate and permanent as a photographic record, free from tintometric and other errors. [Morton and Heilborn, 1930 ; Moore, 1932 ; Gillam, 1934 ; Crews and Cox, 1934].

In vitamin A assay, however, sources of error due to chromogenic behaviour of the fat, free acids, and oxidation should always be taken into consideration. It has been observed that even under the best of conditions, the physical and biological values in the case of cod-liver oil differ more than the experimental error. The best agreement is obtained by the physical method with biological value by measuring absorption at 328 mμ and blue value on the unsaponifiable fraction of the oil. The blue value on the oil is a very crude value of the vitamin potency.

Four samples of ghee were purchased from the market for the experiment. A sample of butter was obtained from the Imperial Institute of Animal Husbandry and Dairying and melted into ghee. This represents a sample of ghee obtained from a mixed herd of cattle. Another sample of butter was obtained from a village and melted into ghee. A sample of ghee was obtained from the same village. This represents ghee prepared from curds. A sample of buffalo ghee was obtained from the Dairy. Goat's milk was procured in the Institute and its butter melted into ghee. Milk from pure breeds of Sindi, Gir, Ayrshire, and Kangian cows was obtained and ghee prepared from it. Another sample of ghee was prepared from the milk of a half-bred cow. Marvo was another imported ghee substitute that was used for comparison. On the above samples the following determinations were made.

Saponification value.—This was determined by refluxing about 1·5 gm. of each sample with $N/2$ alcoholic potash for half an hour, and titrating the excess

of potash with $N/2$ HCl. This result is expressed in milligrams of potash equivalent to 1 gram of fat. *Unsaponifiable matter.*—about 3 to 5 gms. of the sample was saponified with alcoholic potash and the alcohol evaporated off. The aqueous solution of soap was treated with petroleum ether (30°—40°C.). The ether extract was weighed as unsaponifiable matter and expressed in percentages of the fat taken. *Iodine value.*—this was determined by the standard Wiz's method as given by Freyer and Weston. *Acid value.*—about 2 gms. of the sample was dissolved in hot neutral alcohol and titrated directly with $N/10$ NaOH, which gave the free acid present. It is expressed in mgms. per gram. *Refractive index.*—this was determined in an Abbe refractometer at 40°C. *Specific gravity* at 15°C.—this was determined in a specific gravity bottle of 25 c.c. capacity with a thermometer at 40°C. and the necessary correction was applied to bring the value to 15°C. *Yellow value.*—in the absence of standard carotene, the yellow value was expressed in Lovibond tintometric units for 1 cm. thickness of the fat. The fat was diluted with three times its volume of light petrol, and the reading multiplied by four. *Blue value.*—this is the Carr and Price reaction on the fat by antimony trichloride. Ghee as such is not so rich as cod-liver oil, so that it was found that 3 c.c. of ghee dissolved in 1 c.c. of chloroform and then 0·2 c.c. of this added to 2 c.c. of chloroformic antimony trichloride gave measurable blue colour. *Absorption value*—this is the extinction co-efficient of fat in cyclohexane at 328 mμ measured in a Hilger Quartz spectrograph with Spekker photometer. Pairs of photographs, one through the substance used and another through the solvent, were obtained and when the two approached the extinction co-efficient E was obtained : $E=\frac{1 \text{ per cent.}}{1 \text{ cm}}$

Discussion

It will be seen from the table that the values for the pure samples of ghee obtained from different places, and breed of cattle are remarkably near each other. Thus the saponification value is between 220 to 236, while in the case of bazar ghee or hydrogenated sample it is much less, between 187 to 200. Iodine value is between 32 to 37 while with adulterated sample it is between 75 to 60. The same remark applies to acid value, but in this the hydrogenated product is as good as ghee owing to the purification the oil or the fat has to undergo before hydrogenation. The refractive index is very characteristic, the value for pure samples lie between 1·4549 to 1·4540, while for bazar samples it is much higher from 1·4600 to 1·4640. The unsaponfiable matter and specific gravity do not yield any useful figure. The yellow value which represents the carotin content is rich in melted butter but poor in ghee prepared from curds. Goat's ghee and buffalo ghee are pure white in colour, but give a trace of yellow in the tintometer. The bazar and hydrogenated samples are negative. Carotin has been found to yield in the system 60 per cent of vitamin A, and is the pro-vitamin. The presence of this colour in butter or ghee is useful. The colour of butter or

ghee can be influenced with carotinoid feed, but there is a limit to this increase, and depends on the breed of the cow. [Booth, *et al* 1933]. This colour difference, however, may not represent vitamin content variation. Goat's butter and ghee has no colour, but is equally rich in vitamin A, and possibly preformed vitamin and not carotin may cause this difference which is not a safe criterion. Should it be suspected that artificial coloring matter has been added then it can be tested for. Carotin gives an absorption at 450 mμ in the visible region, and negligible in the ultra-violet.

The blue value is absent in bazar ghee and substitutes. *When pure ghee was mixed with even 10 to 15 per cent of marvo the mixture failed to give any blue colour.* The blue colour is inhibited by other substances present in fats. If the blue value is taken on the unsaponifiable matter of ghee, then there is risk of loss in saponification and oxidation. Pure ghee from all sources have given a positive reaction, the value comes to one unit of blue value for 45 to 63 mg. of ghee, or 16 to 22 units per gram. Sherman and Smith find American butter to contain 30 to 50 units per gram. Traichler [1932] finds butter to contain 17 to 50 units per gram. Banerjee and Datta find ghee to contain 10 units per gram from growth experiments. Grewal (Lahore) finds almost the same value, 10 to 12 units per gram. This value is an approximate value. However, the test is positive with pure ghee and negative in the case of bazar samples or substitutes. *Even ten per cent of adulteration completely masks the colour which is a very characteristic and useful finding.* No doubt blue value is an approximate assay of vitamin potency. Evers [1934] finds in the case of cod-liver oil that the true value is average 165 per cent to maximum 217 per cent, more than the observed blue value due to many anomalous chromogenic and physical factors. This means that the disturbing factors in the case of ghee should be thoroughly investigated as has been done in the case of cod-liver oil. This anomaly is mostly in the direction of lowering the value, when examined critically by different methods. This value though rough and quick is very good in this respect, that by this method the error is always on the side of lowering the value than enhancing it. This assay then represents the minimum vitamin A content.

The blue value on the unsaponifiable matter of ghee as determined by Smith and Hazley's method give a figure which is 19 per cent to 25 per cent more than the value without saponification. Here it is necessary to mention that vitamin A is very susceptile to oxidation when purified especially at high temperature. It was found that buffalo and Sindi cow ghee which gave 19·1 and 20·5 B.U. gave by the Smith and Hazley's method 22·5 and 25 B. U. Therefore it is a matter of choice whether the blue value should be determined on the unsaponifiable matter or a correction should be applied by determining the same on the ghee as such as suggested by Smith [1933] in the case of cod-liver oil.

After a number of trials it was found that in the case of Haldiol (B. C. P. W.) a 0·21 per cent solution in alcohol or 2·1 mg. per c.c. or solvent is the proper dilution to get a good band or inflexion for U. V. absorption spectra. Calculated from blue value in the case of Haldiol it works out that 0·3 mg. of absolute vitamin A should be present in solvent per c.c. for spectral observation. In the case of ghee the B. V. is only 25 units so that at least 5 gm. of ghee should be used for absorption spectra work. Hence 5 to 10 gms. of ghee should be saponified in an atmosphere of nitrogen and then the unsaponifiable matter dissolved in the solvent for absorption spectra. The Hilgers have put in a cheap vitagraph (Price £25) for vitamin A assay. This method is not very simple nor can be easily performed without a proper equipment; still the importance of vitamin A in diet requires that it should not be overlooked. Very recently De [1935] has done some estimations in Coonoor and justified the plea.

	Saponification value	Iodine value	Acid value	Unsaponifiable matter per cent	Refractive index at 40° C.	Sp. gr. at $\frac{15\cdot5}{15°C.}$	Yellow value carotin	Blue Value		
							Y. R.	B.	Y.	R.
Bazar No. I	200·0	56·8	1·75	6·50	1·4600	0·9188	..	0	1·0	2·5
Bazar No. II	193·4	67·0	1·40	0·18	1·4612	0·9186	..	0	1·0	2·0
Bazar No. III	189·2	70·9	1·98	3·08	1·4615	0·9185	..	0	1·2	2·5
Bazar No. IV	187·6	72·2	2·04	2·39	1·4627	0·9185	..	0	1·0	1·8
Marvo	198·0	75·4	0·56	1·56	1·4640	0·9221	..	0	1·0	1·3
Imperial Dairy ghee	225·3	33·3	0·56	3·86	1·4547	0·9206	5·2-2·4	1·0	0·1	0·2
Village ghee	229·6	32·6	0·38	1·64	1·4549	0·9203	2·8-1·6	1·2	0·8	0·6
Village butter	230·4	32·5	0·38	2·41	1·4543	0·9186	3·0-1·8	1·1	0·8	0·8
Goat's ghee	236·2	26·5	0·38	2·00	1·4531	0·9172	1·2	1·4	0·2	0·2
Buffalo ghee	231·2	33·8	1·10	2·86	1·4540	0·9176	1·5-0·9	1·3	0·0	0·3
Half-bred cow	229·3	34·9	0·56	2·37	1·4545	0·9192	5·6-1·6	1·4	0·6	0·6
Sindi cow	222·4	37·8	0·56	3·81	1·4548	0·9180	5·6-2·0	1·4	0·8	0·6
Gir cow	223·4	34·5	0·75	2·92	1·4548	0·9176	5·2-2·4	1·2	0·8	0·8
Ayrshire	220·4	37·9	0·56	3·07	1·4548	0·9198	6·0	1·3	0·6	0·6
Kangian	223·7	36·8	0·75	2·71	1·4548	0·9190	6·4	1·3	0·5	0·5

If it is suspected that cod-liver oil, or halibut liver oil has been added to ghee substitutes to make up for the growth promoting factor, then it can be detected from the chemical and physical constants. The odour of ghee is another property that is very characteristic. Pure ghee can always be distinguished from adulterated samples. On heating the sample and boiling for some time malodourous adulterants can be found out without fail.

Goat's ghee is remarkable in that it contains the lowest acid value, iodine value, and refractive index and the highest saponification value. It contains the lowest carotin value but the highest blue value. This ghee then is the best of all the ghees tested so far.

Summary

Vitamin A in ghee can be estimated in a number of ways and should be used in all assays of ghee which is the principal source of vitamin A for Indians.

REFERENCES

Bacharach, A. L. and Smith, E. L. (1934). *Analyst*, ***59***, 695, 70.
Baumann, C. A. and Steenbock, H. (1933). *J. Biol. Chem.*, ***101***, 542.
Booth, R. G (1933). *Biochem. J.* 1189.
Brodie, W. R. (1931). *ibid*, ***92***, 87.
Capper, N. S. (1930). *Biochem. J.*, 980.
—— (1931). *Iibid*, 265.
Coward, K. H., et al (1930). *Biochem. J.*, 1932.
—— (1931). *ibid*, 557, 1102.
—— (1932). *ibid*, 691.
Corbett, R. E. (1933). *J. Biol. Chem.*, ***100***, 657.
Crews, S. K. and Cox, S. J. (1934). *Analyst*, ***59***, 695, 70.
Datta, N. C. and Banerjee, B. N. (1934). *J. Indian Med. Res.* 22.
De, N. K. (1935). *Indian J. Med. Res.*, 23.
Evers, N. (1934). *Analyst*, ***59***, 695, 82.
Fraps, G. S. and Traichier, R. (1932). *J. Ind. Eng. Chem.*, 1079.
Gillam, A. E. (1934). *Biochem. J.*, 79.
Grewal, K. S. (1934). *Q. J. Pharm. & Pharmocology*, Vol. VI, No. 4.
Heilborn, I M. (1932). *Biochem. J.*, ***26***, 1178.
Heilborn, I. M.; Gillmann, A. E. and Morton, R. A. (1931). *Biochem. J.*, 1932.
Lundberg, M. (1931). *Biochem. Z.*, 235-1.
Moore, T. (1930). *Biochem. J.*. 692.
—— (1932). *Biochem. J.* 26-1.
Morgan, R. S. (1932). *Biochem. J.*, 377.
Morton, R. A.; Heilborn, I. M. and Spring, F. S. (1930). *Biochem. J.*, 136.
Morton, R. A.; Heilborn, I M and Thomson, A. (1931). *Biochem. J.*, 20.
Morton, R. A.; and Heilborn, I. M. (1930). *Biochem. J.*, 70, 870.
Sherman, H. C. and Bertis (1928). *J. Biol. Chem*, ***76***, 671.
Sherman, H. C. and Munsell, H. E. (1925). *J. Am. Chem. Soc.*, ***47***, 1639.
Sherman, H. C. and Smith, A. C. (1931). *A. C. S. Monograph.*
Smith, A. C. (1938). *Q. J. Pharmacy*, ***6***, 329.

SELECTED ARTICLES

WORLD WHEAT SUPPLIES AND REQUIREMENTS

BY

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Last October, in an attempt to compare world wheat supplies and requirements, it was estimated that the 1934 world wheat harvest was insufficient to meet probable consumption requirements in the present year, and that, consequently, stocks would have to be drawn upon to fill the gap It was estimated from the information and data then available that the exportable stocks of wheat in existence on 1st August 1934 would be reduced during the present year by 256 million bushels

It is intended in the present article to study the statistical situation of the world wheat market in the light of the data and information which have come to hand subsequently.

I.—World wheat production

Since October several countries have revised their estimates of production, while most of those which had not issued their estimates, and for which tentative figures were calculated, have now communicated their harvest results to the Institute.

If the crops of the U. S. S. R., China, Turkey and those of some minor producing countries, which issue their production statistics irregularly or belatedly, are excluded, the estimates now to hand cover nearly 99 per cent of the world outturn. The approximation of these estimates to the final results may be considered, on the whole, to be fairly close. In the last three years margins of from 1 to 3 per cent have been observed between the preliminary estimates of March and the final figures of world production. It should be added, however, that in these three years the preliminary statistics have shown under-estimates.

The changes made by the new evaluations in the estimates published in October and the corrections in the preliminary figures are numerous and, in several cases, substantial.

In the group of European importing countries an increase of 38 million bushels is to be observed. All the countries in this group, with the exception of Sweden, have made upward revisions in their estimates since October. The most important increases are those of France (about 24 million bushels), Germany (6 million), and the United Kingdom (3 millions).

In the group of European exporting countries, increases in the Romanian (3 million bushels) and Lithuanian (about 1 million) estimates must be set against reductions in the evaluations of Bulgaria (4 million) and Yugoslavia (5 million). The total of this group thus shows a decrease of 5 million bushels.

Total European production is thus 33 million bushels greater than the total arrived at in October. In the case of several countries only first estimates of the harvest are available and the present total may thus undergo further modification, but the possible difference will probably be less than that of 40 million bushels, which occurred last year between the March estimate and the final result. An upward revision of at most 15 to 20 million bushels of the total now arrived at seems to be the most warrantable expectation.

In North America, the latest estimates made by Canada and the United States practically confirm the provisional estimates of October but involve slight reductions which for the two countries taken together, amount to a total of 3 million bushels.

World wheat production (1)

(Million bushels)

Years	Europe			North America	South America	Asia (1)	Africa	Oceania	Total	U. S. S. R.
	Importing countries	Exporting countries	Total							
Average 1923-27	920	323	1,243	1,210	275	402	108	143	3,381	676
1928	977	433	1,409	1,491	399	342	116	168	3,925	807
1929	1,071	378	1,449	1,139	221	384	136	134	3,463	694
1930	915	445	1,360	1,322	273	459	115	221	3,750	989
1931	974	462	1,435	1,270	264	407	131	197	3,704	753
1932	1,212	280	1,492	1,197	286	393	140	224	3,732	744
1933	1,292	455	1,747	823	347	420	121	185	3,643	1,019
1934—										
October forecast	1,150	327	1,477	786	294	426	136	147	3,266	...
March estimate	1,188	322	1,510	783	305	426	150	142	3,316	..

(1) Not including China, Iran (Persia), Turkey and Iraq.

The preliminary figures available at present for South America exceed the conjectural estimates made in October by only 11 million bushels. It appears,

however, that the first official estimate of the Argentine crop did not make sufficient allowance for the damage resulting from the bad weather experienced in some areas during the final stage of ripening. Estimates made in commercial quarters are from 20 to 30 million bushels smaller.

The estimate made in Australia in October has been slightly reduced by 2 million bushels. The small output of New Zealand is also smaller than that anticipated. In all the reduction in the estimates of these two countries from the October figure is about 5 million bushels.

It should be remembered, however, that the present estimates of the crops in the southern hemisphere are of a preliminary character and that, in the case of several South American countries, owing to the absence of official estimates, approximate calculations had to be made. The final results, consequently, may involve changes in the totals now issued.

The figures for Asia remain the same while the total of the African crop has been increased by the substantial amount of 14 million bushels as a result of the good crop obtained in the Union of South Africa and, more particularly, of the increase made in the estimate of French Morocco.

To sum up, the latest estimates confirm that the 1934 world wheat crop, excluding that of the U. S. S. R., China, Turkey and Iran (Persia), is the smallest recorded since 1924.

It appears to be 327 million bushels, or 9 per cent smaller than that of 1933 and 400 million, or 11 per cent, below the average of the five years 1928 to 1932. The total has been particularly affected by the poor results obtained in all the great exporting countries. The North American crops were the smallest harvested for a long series of years and were even below the pre-war averages. The harvest of the Danube countries was the smallest obtained since 1924 with the exception of the disastrous failure of 1932 following rust attacks. That of Australia is the smallest obtained in the last five years. That of Argentina, as estimated at present, is about average or slightly above average.

Official estimates of the 1934 outturn in the U. S. S. R. have not yet been issued and there are always discrepancies in the various assessments, the crop being considered plentiful by the official authorities of the country and poor or mediocre in commercial quarters. There are consequently no grounds for modifying the view of the crop put forward last October in the following terms: U. S. S. R. wheat production this year is very irregular from place to place. On the whole, it is appreciably smaller than that of 1933, but so far from being poor, or still less, a failure, it approximates to the average without perhaps quite reaching it. The estimate of Mr. Cairns, the Secretary of the Wheat Advisory Committee, which indicates a crop of 775 million bushels against the 1928-32 average of 797 millions, seems to confirm this expectation.

II.—Exportable supplies of wheat

To calculate the quantities exportable from the surplus-producing countries the amounts necessary for internal consumption and for normal carry-over, that is, the reserves necessary for the gap between one season and the other—hitherto taken as equivalent to one month's normal consumption—have been subtracted from the total supplies existing in each country, but the quantities remaining at the end of the season in the exporting countries, especially in those of North America, have never, even in years of heavy external demand, sunk to the low level at which they have hitherto been placed. Thus, to bring the statistical expression of the situation into closer conformity with reality, we are from this year changing the criterion we have so far adopted for the calculation of quantities exportable, substituting for the minimum theoretical carryover equivalent to one month's consumption the minimum carryover actually found in a long series of years; owing to this modification the data we now publish for quantities exportable and for exportable stocks remaining in exporting countries at the end of the season constitute a series entirely different from that published in previous Crop Reports. The situation as regards quantities exportable in the various groups of exporters is as follows.

North America.—In the United States the final crop estimate has involved only an insignificant modification of the estimate published last October. As regards internal consumption, which we have estimated at 625 million bushels, an increase of about 5 per cent on that of the preceding year, it appears that our estimate must undergo a further, though slight, increase: the internal prices of wheat have in fact fallen since September; the margin of superiority that existed with reference to the prices of maize was thus very much reduced and this stimulated the greater utilization of wheat for feed in a year of great scarcity in fodder cereals. At the end of last December the Bureau of Agricultural Economics of the Department of Agriculture at Washington estimated the internal consumption of wheat for the United States in the current season at 655 million bushels. Stanford University confirmed in January its September estimate of 641 millions and Mr. Cairns, Secretary of the Wheat Advisory Committee, recently raised his November estimate from 635 to 651 million bushels; between these authorities there are therefore only negligible differences. Adopting for consumption the official figure of 655 million bushels and for minimum carryover the lowest figure of the last ten years, namely 105 millions in 1926, the quantity necessary for internal requirements this season is 760 million bushels. The 1934 crop having amounted to 496 million, there remains to be met a deficit of 264 million bushels. Deducting from the total stocks existing at the beginning of the season, estimated at 310 millions, the deficit of 264 millions, the amount available in the United States for export in 1934-35 is 46 millions against 237 millions in 1933-34 and an average of 360 millions in the five preceding years.

For Canada the final estimate of the crop, published in January, is almost the same as that published in October, there being a practically negligible decrease; the total supplies (276 millions of production and 203 millions of stocks) are 479 million bushels. As for internal requirements, we retain without change the estimate of 110 million bushels adopted in October for internal consumption. This amount is practically the same as that in the preceding season and there are no reasons to expect any appreciable change, whether in the quantities absorbed for human food, or in those for feed and seed; this estimate coincides, too, almost perfectly with the estimates recently published by the Canadian Department of Agriculture (106 millions), Stanford University (109 millions) and the Secretary of the Wheat Advisory Committee (109 millions). For the carryover at the end of the season we adopt as for the United States the minimum carryover of the last ten years, 26 million bushels (1925) and the total internal requirements of Canada are therefore 136 million bushels; deducting these requirements from the total supplies, the amount available for export in the current season is 343 millions against 366 millions in 1933-34 and 388 millions on the average of the five years ending 1932-33.

Argentina and Australia.—For Argentina, in default of an official estimate, an approximate figure of 240 million bushels had been taken for the production, and stocks on 1st August 1934 had been calculated at 96 million bushels; the surplus available for export in 1934-35, after deduction of 90 millions for internal consumption, was thus 246 million bushels. The first official estimate of production gave a figure of 252 million bushels; the second estimate has not yet been published but it is generally believed that, contrary to what occurred last year, there will be a reduction on the volume as previously forecast, the reductions indicated by commercial sources vary from 20 to 30 million bushels.*

As regards stocks in Argentina on 1st August 1934, export figures from 1st August to 31st December 1934 (73·4 million bushels) and the amount remaining in the country at the beginning of the new harvest (15·5 millions), show a total nearly 7 millions smaller than the amount of the calculated stocks. It is highly probable that this difference indicates an overestimation of last year's Argentine crop as given in the last statistics.

Taking account of the various elements there is room for a slight decrease in the surplus exportable from Argentina in the current season, from 246 to 230 million bushels; Argentina would thus have exportable supplies almost the same as those of the past season (236 millions) but a little above the previous five-year average (209 millions).

For Australia the crop is stated to be slightly smaller than that forecast in October, which has been lowered from 137 to 135 million bushels. Stocks on

* While the present Crop Report was in the press, the Institute received a cable from the Argentine Government intimating that the second estimate of wheat production was 238 million bushels.

1st August being calculated at 77 million, total supplies for the current season are 212 million bushels. Deducting 50 millions for internal requirements, the exportable surplus of Australian wheat for 1934-35 is 162 millions; this surplus would be practically the same as both that of last year and the five-year average.

*India.**—As the October forecast indicated, the volume of the 1934 crop corresponded perfectly with the internal requirements of the country and only insignificant quantities were put on the world market. The new crop, which will be harvested next month, though covering an area slightly smaller than that of 1934, may give a higher outturn, weather having been more favourable than a year ago. It is, therefore, not impossible that India may reappear on the world market during the closing months of the year, but, if world prices remain at the present level, Indian competition will be limited to small quantities, particularly in view of the rather poor rice harvest.

U. S. S. R.—Any forecast of the exportable Soviet wheat supplies in a given year is generally pure guesswork, for statistics generally are lacking, internal consumption varies greatly and the commercial policy of the Government plays an important part in the determination of the volume of exports.

In October last, in the absence of reliable statistical information on the 1934 harvest, the opinion was expressed that Soviet exports would only with difficulty exceed 15 million bushels, thus falling far short of the quantity exported in 1933-34. The Secretary of the Wheat Advisory Committee made a forecast in August of 10 million bushels, while Stanford University in its September estimate gave an amount slightly below 15 million bushels. Recent official statistics of Soviet exports are unavailable, but the statistics on shipments prepared by Mr. Broomhall, which are usually smaller than those actually issued by the Soviet Government, place total exports at barely 1·7 million bushels for the period 1st August—23rd March, which covers nearly two thirds of the year, while in the corresponding period a year ago, the shipments, according to the same authority, reached 26 million bushels. No exports were recorded after the middle of December. The reduced quantity and the early cessation of exports suggest that the total contribution of Russia to the world wheat trade will hardly reach 3 million bushels during the present year.

European exporting countries.—As a result of the reductions in the harvest estimates of Bulgaria and Yugoslavia, which exceed the increases in those of Romania and Lithuania, the total outturn in 1934 of this group of countries, including the Danube countries, Poland and Lithuania, is reduced from 327 to

* The fourth all-India wheat forecast season 1934-35 estimates the crop just harvested at 34,478,000 acres and 9,823,000 tons as compared to 35,720,000 acres and 9,382,000 tons at the same time last year and a final estimate for 1933-34 of 36,062,000 acres and 9,358,000 tons.

322 million bushels. At the same time, the rye and maize crops, which are used to a great extent for human consumption, fulfilled the October anticipation in the case of rye and proved to be much more plentiful in the case of maize. Notwithstanding the poor wheat outturn in 1934, an export surplus of about 20 million bushels was forecast for this group having regard not only to the large stocks on hand at the beginning of the season but also to the financial necessity of these countries for the preservation of the balance in their international payments. Up to the end of January, 11 million bushels of this surplus had been exported, most of this quantity consisting of Hungarian or Yugoslav wheat. No shipments were made by Romania and Bulgaria, which had prohibited exports during the first part of this year. The reasons for the prohibition lost their force when a good maize crop become assured and it is probable that shipments of Bulgarian and Romanian wheat will be resumed in the spring. The conclusion of agreements and conventions for preferential treatment for the placing of Hungarian wheat in Italy and Austria, of Romanian wheat in Czechoslovakia and Germany, and of Yugoslav wheat in Austria and Germany, is likely to assist in the disposal of Danubian wheat in the last months of the season, when exports, however, will be influenced by the prospects of the new crop in these countries. When account is taken of these various elements, of the trend of Danubian exports during the first six months of the year, of the possibility of disposing of some wheat in the neighbouring countries, and of the good condition of the growing crops, it appears probable that the whole exportable surplus of 20 million bushels will actually be exported during the course of the year, unlike the experience of last year when out of an exportable surplus of 55 million bushels only 37 million bushels could be disposed of abroad.

North Africa and other countries.—Of the three exporting countries of North Africa, Algoria and Tunisia have modified their estimates of production only to a negligible extent while Morocco has lately increased its estimate very considerably, raising it from 31 million to 39 million bushels; save in Tunisia, where it has been bad, production of barley appears definitely good in Algeria and excellent in Morocco.

In October we calculated the exportable surplus of North African wheat at 40 million bushels and the actual exports this season at only 24 million bushels, a result of the present difficulties of placing wheat on the metropolitan market. These forecasts should in all probability be maintained, despite the increase in supplies in Morocco, since the difference between the prices of wheat and barley favours larger internal consumption of wheat and more considerable exports of barley.

For the group of other surplus-producing countries, Turkey, Iran (Persia), Iraq, Chile and Uruguay, for which we calculated an export surplus of 6 million

bushels, it would appear necessary to reduce the total, the majority of these countries having had crops smaller than was forecast in October, and especially the two of South America. For these countries of North Africa and elsewhere taken together the exportable surplus of wheat, calculated in October at 46 million bushels, is thus reduced to 42 millions.

Summarizing, the supplies available to meet the demand of the importing countries in the current season are estimated as follows, in comparison with the forecast made last October and the data of preceding years.

Exportable supplies of wheat

(Million bushels)

Seasons	Canada	United States	Argentina	Australia	U. S. S. R.	India	Danubian countries(1)	North Africa(2)	Afloat	Totals
1926-27 . .	321	220	195	130	49	11	44	2	39	1,011
1927-28 . .	387	229	246	96	3	8	31	15	46	1,061
1928-29 . .	496	317	331	136	0	0	34	18	45	1,377
1929-30 . .	292	362	186	100	10	0	55	20	37	1,062
1930-31 . .	383	343	173	200	113	0	50	22	39	1,323
1931-32 . .	319	431	172	192	64	2	84	26	38	1,328
1932-33 . .	452	347	184	192	19	0	13	21	30	1,258
1933-34 . .	366	237	236	162	32	0	55	24	32	1,144
1934-35—										
October 1934, forecast	345	75	246	164	15	0	20	46	34	945
March 1935 estimate	343	46	230	162	3	0	20	42	34	880

(1) Including Poland and Lithuania.
(2) Including the other minor exporting countries.

Excepting the Danubian countries for which the export surplus is unchanged, the figures calculated in October have undergone modifications for all countries, which, though for the most part small, together involve a total reduction of about 60 million bushels in the world export surplus; this also appears from the forecasts already made, to be the smallest experienced in the last ten years, being 264 million bushels (23 per cent) less than that of last year and 497 million (36 per cent) less than the maximum of 1928-29.

Of the large exporting countries, only the United States show a marked decrease in their surplus from the figure of last year; the others have practically the same quantities as last year. Of the minor exporters, only North Africa

shows an increase in supply while the U. S. S. R. and the Danubian countries have heavily reduced their supplies.

In the first half of the current season (from 1st August 1934 to 31st January 1935) the international movement of wheat was a little smaller than in the first half of last season, the total exports of the surplus-producing countries having been 264 million bushels against 282 millions in 1933-34.

World net exports of wheat (including flour in terms of wheat)

(Million bushels)

Months	1934-35	1933-34	1932-33	1931-32	1930-31	1929-30
August	51	45	41	66	77	71
September	41	51	48	78	74	57
October	50	46	62	74	84	60
November	42	41	54	67	77	51
December	38	51	60	64	59	50
January	42	48	62	62	54	48
February	..	44	64	73	70	45
March	..	50	64	74	67	50
April	..	35	40	70	62	42
May	..	44	52	67	81	50
June	..	45	42	59	67	51
July	..	46	44	45	52	53
Total season	..	546	633	799	824	628
Total August—January	264	282	327	411	425	337

Comparing the quantities exportable from each country with the actual exports during the first six months, the balance exportable on 1st Feburay was as follows.

Exportable surplus of wheat at the beginning and at the middle of the season

(Million bushels)

	Season 1934-35			Season 1933-34		
	Total exportable surplus	Exports from August to January	Exportable remainder on 1st February	Total exportable surplus	Exports from August to January	Exportable remainder on 1st February
Canada . .	343	91	252	366	109	257
United States .	46	2*	48	237	15	222
Argentina .	230	91	139	236	54	182
Australia. .	162	54	108	162	42	120
U. S. S. R. .	3	2	1	32	29	3
India . .	0	0	0	0	0	0
Danubian countries.	20	11	9	55	21	34
North Africa .	42	17	25	24	12	12
Total .	846	264	582	1,112	282	830
Afloat . .	34	..	34	32	..	32
General Total .	880	..	616	1,144	..	862

* Net imports deducted from the totals.

The United States, though having available supplies larger than their internal needs, were on balance importers in order to meet their requirements of hard wheats and fodder cereals ; their absence from the international market as sellers is due not to an absolute shortage of exportable supplies but to the level of their internal prices.

The United States and the U. S. S. R. being outside the market, the exportable surplus remaining at the end of the sixth month of the current season was almost entirely concentrated in Canada, Argentina and Australia, Canada having itself a quantity larger than that of the two other countries together ; Australia and Argentina and especially the latter had on 1st February 1935 exportable supplies smaller than those on 1st February 1934, while Canada had supplies almost the same. On the whole the exportable supplies on 1st February were nearly 250 million bushels smaller than those of 1934.

III.—Requirements of importing countries

European importing countries.—The wheat requirements of the European importing countries in the present year were estimated in October to amount to 430 million bushels, or about 40 millions more than the greatly reduced requirements of the preceding year. It has already been pointed out that since October the crop estimates of several important European countries have been increased, those of France, Germany and the United Kingdom in particular, and that, in all, these revisions result in an increase of 38 million bushels in the resources of these countries.

Moreover, none of the other factors (size of the other food crops, restrictions on international trade, etc.), on which the forecast of European wheat requirements was based, has undergone any significant modification likely to result in an increase in demand. On the contrary, in several countries, the restrictive measures and the obstacles to trade have been intensified and made stricter and more rigid.

If account is taken of the very good harvest results and of the further restrictions imposed on international trade, the estimates of the probable European importations will have to be revised, especially so since the trend of imports in the first six months of the year indicates that these are, on the whole, smaller in volume than last year and rather smaller than was anticipated.

Net imports of wheat into Europe

(Million bushels)

Year	First six months (August-January)	Last six months (February-July)	Total for the year
1927-28	328	328	656
1928-29	319	338	657
1929-30	275	239	514
1930-31	315	301	616
1931-32	295	319	614
1932-33	216	233	449
1933-34	194	198	392
1934-35	182	..	..

The following table shows the revised estimates of import requirements in the present year for each of the importing countries compared with the forecasts made six months ago. The actual imports of the same countries during the first six months and the balance to be imported to cover the anticipated requirements are also shown.

Estimates of wheat import requirements in European importing countries

(Million bushels)

Countries	Estimates of import requirements in 1934-35		Actual net imports from August 1934 to January 1935	Probable import requirements from February to July 1935
	October forecast	March revised estimate		
Germany	18	15	7	8
Austria	15	10	4	6
Belgium and Luxemburg .	45	46	22	24
Denmark	16	19	11	8
Spain and Portugal . .	0	0	0	0
Estonia, Finland, Latvia	4	4	2	2
France	0	20*	5*	15*
British Isles	230	225	104	121
Greece	10	10	5	5
Italy	22	15	3	12
Netherlands	20	22	11	11
Sweden and Norway . .	8	9	5	4
Switzerland	22	22	10	12
Czechoslovakia . . .	15	8	0	8
Malta, Albania, etc. . . .	5	5	3	2
Total .	430	390	182	208

* Net exports deducted from the total.

The estimate of the probable requirements of Europe is thus reduced by from 430 to 390 million bushels, a decrease of 40 millions on the October forecast.

It should be observed that a considerable part of this reduction is to be attributed to the situation in France, which has become temporarily an exporter of wheat. In October it was expected that exports of French wheat and imports from North Africa would balance each other exactly. The heavy volume of the internal supplies of France has given rise to insuperable difficulties as the 1934 crop proved to be much greater than the first estimates indicated and this country was obliged to place part of its surplus on the external market. At the last meeting of the Wheat Advisory Committee, held in Budapest last November, France obtained the agreement of the other exporting countries to an export quota of 33 million bushels, two-thirds of which was to be denatured wheat. However, in view of the difficulties of disposing of denatured wheat and the volume of North African shipments to the French market, it seems doubtful whether net exports of French wheat will exceed a total of 20 million bushels in the course of the present season.

The decrease in the import requirements of Germany and the United Kingdom is the outcome of the good harvest results in these countries, while in Italy and Czechoslovakia it is due to the carryover from last year which appears to have been greater than was expected.

The expected reduction in Austrian requirements is due to the fact that in this country rye imports fills part of the wheat requirements.

The increase in the amounts attributed to Belgium, Denmark and the Netherlands is due to the increasing use of fodder wheat in place of rye, imports of which into these three countries have shown a weakening this year.

The reduction thus made in the first estimate of the probable requirements of the various European countries amounts to 40 million bushels. It is to be observed that the estimates of the probable European demand made at the beginning of the season by the best qualified authorities have also been revised, and an appreciable reduction is made in each case.

Principal estimates of European wheat requirements

(Million bushels)

United States Department of Agriculture		Broomhall (shipments)	
September estimate	450	July estimate	440
October „	440	August „	448
January „	400	November „	448
		February „	416
Wheat Advisory Committee		International Institute of Agriculture	
August estimate	465	October estimate	430
November „	440		
March „	400	March „	390

If this figure of probable imports of 390 million bushels is added to a production of 1,188 millions, the apparent consumption of the European importing countries would amount to about 1,580 millions, a total slightly smaller than the average of recent years. This conclusion seems to confirm the opinion that several countries, at the end of the year, will be holding stocks reduced to a normal level, and, in some cases, below it. In some countries, however, stocks will still be heavy on 1 August 1935.

Extra-European importing countries.—For this group of countries it was expected in October, taking into account the growth of demand mostly in China, Manchukuo and Egypt, that imports would be around 180 million bushels, an increase of about 30 millions on the total imported in 1933-34.

For China the main cause of the increase in the demand for wheat despite the relatively large crop in 1934 was the smallness of the rice crop, which was greatly reduced by drought in several important areas of production, admitting that the deficit would be met principally by imported rice, owing to the difficulty of substituting wheat for rice in the diet of large masses of Chinese consumers, it was assumed that the demand for wheat would also be influenced, at any rate to some small degree. Although Chinese statistics for the first six months of the present year again show a reduction in imports compared with the corresponding period a year ago, it should be remembered that the bulk of Chinese imports occur normally in the second half of the year and it is in the February-August period that we expect the anticipated increase will take place. As for Manchukuo the poor crops of all cereals in 1934 gave grounds for expecting a considerable increase in demand for wheat, all the more because of the economic recovery and the rise in the standard of living in that country. There are as yet no direct statistical data for the trade of Manchukuo but the statistics published by the Bureau of Agricultural Economics of the Department of Agriculture at Washington show that from July to December imports were 15 million bushels, an increase of 4 millions on last year.

Egyptian statistics of wheat imports in the first six months of the season did not show the appreciable recovery in demand that had been expected. It would appear, however, that the internal supplies on which the country has so far depended are exceptionally small.

In Japan the very bad rice crop appears to operate in the same direction as in China. Though the excellent wheat crop of 1934 led last October to the expectation of a slight decline, demand in the current season appears larger than last season.

In all it seems that our October forecast of 180 million bushels for the probable import of extra-European countries need not be modified, being sufficiently near present conjectures. In any case, the estimates made elsewhere for probable requirements of extra-European countries, which were initially rather low, have lately been appreciably raised so that they are now fairly close to those of the Institute.

Principal estimates of import requirements in extra-European countries

Wheat Advisory Committee		Broomhall (shipments)	
August estimate	130	July estimate	112
November estimate . . .	160	August estimate	128
March estimate	165	November estimate . . .	128
		February estimate . . .	136

Summarizing, this examination of the situation in the different consuming countries brings a reduction of 40 million bushels in the import requirements of the European countries, now estimated at 390 million bushels, and leaves unchanged the forecast of requirements in extra-European countries, calculated at 180 millions, world import requirements are thus placed at 570 million bushels against 610 millions last October.

In the following table the various estimates of world import requirements are compared.

Principal estimates of world wheat requirements

Wheat Advisory Committee		Broomhall (shipments)	
August estimate	595	July estimate	552
November estimate . . .	600	August estimate	576
March estimate	565	November estimate . . .	576
		March estimate	552
Stanford University		Internation Institute of Agriculture	
September estimate . . .	600	October estimate . . .	610
January estimate . . .	575	March estimate	570

IV.—THE POSITION OF WORLD WHEAT SUPPLIES AND REQUIREMENTS

The statistical situation of wheat this year, revised according to all the information available up to the present shows the following features.

World production, trade and stocks of wheat

(Million bushels)

Season	World production				World exportable supplies			World requirements (net exports)	World exportable end-of-season stocks
	Total (1)	Exporting countries	Importing countries	U. S. S. R.	Total	Aggregate excluding U. S. S. R.	U. S. S. R.		
1926-27 . .	3,396	2,397	999	914	1,011	962	49	827	184
1927-28 . .	3,611	2,534	1,077	797	1,061	1,058	3	809	252
1928-29 . .	3,925	2,823	1,102	807	1,377	1,377	0	923	454
1929-30 . .	3,463	2,240	1,223	694	1,062	1,052	10	628	434
1930-31 . .	3,750	2,688	1,062	989	1,323	1,210	113	824	499
1931-32 . .	3,704	2,575	1,129	753	1,328	1,264	64	799	529
1932-33 . .	3,732	2,374	1,358	744	1,258	1,239	19	633	625
1933-34 . .	3,643	2,203	1,440	1,019	1,144	1,012	32	546	598
1934-35 . .	3,316	1,966	1 350	...	880	877	3	570	310

(1) Excluding U. S. S. R., China, Turkey, Iran (Persia) and Iraq.

World exportable supplies are estimated at 880 million bushels, the forecast made last October having been reduced by 65 millions.

These supplies are the lowest recorded in the last ten years and are about 264 million bushels, or 23 per cent smaller than those of last year, and 500 millions or 36 per cent below the record surplus which existed in 1928-29.

About two-thirds, or 600 million bushels, of this quantity consists of wheat carried over from the preceding year. The surplus provided by the poor world crop of 1934 amounted to only 280 million bushels.

The revised estimate of the probable requirements of the importing countries gives a total of 570 million bushels. A reduction of about 40 millions has been made in the October estimate resulting from the smaller probable European demand.

The estimate of the probable imports of the non-European countries remains unchanged at 180 million bushels.

Thus calculated, world import requirements, on the whole, are barely 24 million bushels larger than the extremely reduced demand of last year.

Statistics of the trade movement of wheat during the first six months of this year show that net exports of wheat and wheat flour of all the exporting countries were 264 million bushels while in the corresponding semester of the past season they rose to 282 million bushels. Imports into Europe in the same period were about 182 million bushels against 194 million last season.

The weakness that was foreseen in the international demand for wheat and that is confirmed by the commercial movement in the first half of the season is to be imputed in the first place to the abundant food production in the importing countries but also in large part to the present economic situation, which is characterised by hinderances of all sorts to international movement of goods and currency.

From a comparison between the requirements of importing countries, which are 570 million bushels, and exportable supplies in surplus-producing countries, it would seem that the exportable surplus from the 1934 crop (280 million bushels) covers only about half of the world demand. To meet the deficit it will be necessary to take difference of 290 millions from the exportable stocks of old crops, which on 1 August 1934 amounted to 598 million bushels. It follows that these stocks will be reduced on 1 August 1935 to 310 million bushels.

This reduction of 290 millions on the total of exportable stocks, which is larger than was foreseen last October, when it was estimated at 246 millions, constitutes without doubt an improvement of fundamental importance in the international wheat market, so many years depressed by the heavy burden of accumulated stocks. If the level of international wheat prices has been influenced only slightly by the change in the statistical situation in the current season, this is due to the persistent impression that world wheat production is potentially not yet balanced by the present effective demand.

V.—New crop outlook

In Europe the area sown with winter wheat is slightly larger. To the figures of the areas sown to winter wheat which were known last month must now be added those of Spain and Algeria. The figures now to hand for these two countries and the slight modifications made in some of the earlier estimates hardly affect the general conclusions outlined in the February issue of the *Crop Report.* By adding together the estimates of the areas sown to winter wheat in the eighteen countries which have reported to the Institute and which together grow about 4/5 of the winter wheat of the northern hemisphere, a total of 174 million acres is obtained, or about 5 million acres more than the corresponding figure of last year.

Some indications are available of the sowings of spring wheat in the three countries where this crop is most important, namely, the U. S. S. R., the United States and Canada In the other producing areas, spring wheat forms only a small proportion of the total wheat area.

In the U. S. S. R. the area to be sown to spring wheat, according to the plan drawn up by the Government, is almost equal to that stipulated in the plan of last year, namely, 57,360,000 acres against 57,430,000 acres.

The Department of Agriculture in the United States, on the basis of an enquiry made among farmers with the object of determining the area intended to be sown with spring wheat at the beginning of March, estimates, after making allowance indicated by past experience for the influence of weather conditions at the time of sowing and for the losses likely to be shown by the areas sown, that the probable acreage for harvest in 1935 will be 17,847,000 acres.

By way of comparison it is useful to remember that, though the area sown to spring wheat last year was 18,521,000 acres, the area actually harvested, owing to the exceptional damage resulting from the drought, was only 9,290,000 acres. After the enquiry into farmers' intentions had been carried out, it was rumoured that the Government of the United States, in view of the rather unfavourable outlook of the winter wheat crop in some important areas, might abandon its contemplated programme of restriction of spring crops. It is possible, therefore, that the area that will actually be sown to spring wheat in the United States will exceed that on which the above-mentioned estimate was based.

No official forecast of the probable extent of sowings in Canada is yet avail able. All the available information, however, points to a reduction in spring crops compared with last year.

In most European countries the weather in the second half of February and in the first days of March was marked by rather high temperatures, and in many instances, by considerable rain. Subsequently there was a brief spell of severe cold which does not appear, however, to have caused appreciable damage to the crops, and which was even, in certain cases, of assistance in retarding too forward

development of the plants. The situation in the middle of March was considered to be generally satisfactory.

Weather conditions in the U. S. S. R. were fairly similar to those experienced in Europe. The considerable fall in temperature which occurred in the first days of March produced an ice-crust in several areas where the ground had previously thawed, but it is not possible to indicate the extent to which the crops suffered.

Several areas in the United States benefited from moisture in the form of rain or snow during the second half of February and the first of March. But drought persisted in the middle of the month in a considerable part of the winter wheat producing centres in the West, and during the period considered there were violent dust storms in the area between Western Oklahoma and North-eastern Wyoming.

Information on the condition of the crops in India is favourable at present and suggests that yields will be greater than those of last year.

Turning to North Africa, the crop situation in Egypt improved in February, and at the beginning of March it was normal. The season in Tunisia has been unfavourable owing to the excessive wet, while in Algeria there are complaints of drought. The appearance of crops in French Morocco continued to be fairly satisfactory on the whole.

RICE PRODUCTION IN MONSOON ASIA AND THE EASTERN TRADE IN RICE*

BY

C. J. ROBERTSON.

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Given the preponderant part of the world's rice crop that is produced in monsoon Asia and the fact that by far the greater proportion of the trade in the commodity passes between these countries, the estimates now available, enable the general outlines of the world rice situation for 1934-35 to be summarized. The available statistical data show that, excluding China, for which official estimates have been available only in the last two years, production this season has fallen to a very low level, much below anything experienced during the last decennium. Even when China, which in 1933-34 is officially stated to have produced 115,000 million pounds of rough rice, is taken into consideration it is probable, given the reports of crop condition that have so far been published, that this statement will hold good.

World production of rough rice (1)

(Million pounds)

1934-35 (very approximate)	176,000
1933-34	199,000
1932-33	196,000
1931-32	195,500
1930-31	201,000
1925-26/1929-30 (average)	187,800

(1) Not including that of China, the U. S. S. R., Iran (Persia) and certain other countries of smaller production for which statistics are very incomplete or are entirely lacking.

Of the three major exporting countries that must place a large part of their surplus in non-preferential markets, Burma has had a small crop and Siam a crop rather larger than last season while French Indo-China does not appear likely, as far as available indications go, to have a crop above average. Total supplies in Chosen and Taiwan, where production has been encouraged by the Japanese Government to a point at which they are normally more than capable of meeting the deficiency in the metropolitan market, are likely to be smaller this season. In

(*) Unless otherwise stated all data have been converted to terms of milled rice and derivatives, the latter including broken rice, white meal, flour and polish but not bran.

China and India, which, though the world's largest producers, have large deficits, production appears to have been smaller than last year in the former while India has had its smallest crop since 1927-28. Japan, which is surpassed only by China and India in the volume of its production, has had an exceptionally small crop this season while reports from the remaining deficit countries, British Malaya, Ceylon, the Netherlands East Indies and the Philippines, in every case lead to expectations of small production.

THE SITUATION IN BURMA, FRENCH INDO-CHINA AND SIAM

The price of Big Mills specials at Rangoon had fallen fairly continuously from the latter part of November 1933 to the end of March 1934 but in May and June, when sowings were being made, it was rapidly regaining its previous maximum. This did not, however, prevent a decline of 252,600 acres, or 2·0 per cent on the previous year and 0·8 per cent on the average, in the area sown in Burma in 1934. Though the monsoon was on the whole fairly strong the late rains were poor and there was considerable damage by insects. The final estimate of area destroyed was, however, 95,400 acres less than in 1933-34 so that the area to mature was only 157,200 acres less than in that season. In Lower Burma, from which the major portion of the export surplus is derived, there were decreases of 17,400 acres in area sown, 5,400 acres in area destroyed and consequently 12,000 in area matured. Production is estimated at 11,282 million pounds of rice and rice products, a decrease of 12·6 per cent on that of the previous year and of 6·1 per cent on the average. The fall in production was most marked in Insein, Bassein, Hanthawaddy and Pyapon. It should be noted, however, that the area sown in Burma in 1933-34 was the largest since 1930-31, while the production was a record, thanks to particularly favourable weather.

Production and net export of major exporting countries

(Million pounds rice and derivatives)

Year	Production			Year	Net export			
	Burma	French Indo-China	Siam		Burma (1) to foreign countries	Burma (1) to Indian ports	French Indo-China	Siam (2)
1934-35	11,282	...	8,572	1935	...	...	...	...
1933-34	12,905	9,876	8,280	1934	2,947	5,752	3,253	4,128
1932-33	12,228	9,305	8,460	1933	4,072	3,669	2,698	3,568
1931-32	10,458	9,034	6,727	1932	4,688	2,341	2,624	3,379
1930-31	12,800	9,624	7,980	1931	4,808	3,530	2,101	2,683
1929-30	12,410	9,557	6,407	1930	5,763	2,239	2,465	2,315
1928-29	12,181	9,314	6,419	1929	4,366	2,521	3,229	2,625
1927-28	12,161	10,333	7,547	1928	3,754	3,174	3,904	3,500
1926-27	12,728	9,561	8,641	1927	4,870	2,682	3,630	3,708
1925-26	11,805	9,440	6,933	1926	5,134	1,619	3,506	2,780

(1) The official data are for rice both in the husk and not in the husk but, as practically all the rice exported is milled, they have been taken to represent milled rice and derivatives.—(2) Exports from Bangkok, which make up 98 of the per cent value of the total rice exports from Siam. Data refer to the season from 1 December to 30 November.

The export surplus of French Indo-China is derived in the main from Cochin-China. While preparation of the land and sowings were carried out under generally fairly good conditions, transplanting was hindered by drought. The crop was somewhat affected by drought in the east. In the central provinces in particular there was damage by floods of the Mekong and Dongnai, while in the west both flood and drought damage occurred. Save in a few districts, however, these irregular moisture conditions, together with low temperatures, disease and insects, appear, according to the most recent reports available, to have caused a delay in the crop rather than permanent damage, as appearance was said to be generally good when harvesting of the main crop began in December. Arrivals of new crop in the first half of January were still below normal for that period. In Cambodia, from which part of the export is derived, the long drought in the earlier part of the season hindered the crop, especially in the higher padis, and increased insect damage, while the exceptionally rapid rise of the Mekong and Tonle-Sap later caused losses. On the whole, however, conditions in the latter part of the season, apart from an interruption of the rains and a fall in temperature in mid-October, appear to have been better, losses were smaller than expected and yield higher. In Tonkin and Annam crops have been affected seriously by drought, typhoon and flood.

Production in French Indo-China

(Million pounds rice and rice derivatives)

Year	Cochin-China	Cambodia	Tonkin	Annam	Laos
1934-35	..	..	2,409	..	..
1933-34	3,617	737	2,839	1,600	583
1932-33	3,108	1,225	2,890	1,519	563
1931-32	3,636	781	2,903	1,183	531
1930-31	2,985	1,446	3,220	1,442	531
1929-30	3,484	1,047	2,990	1,505	531
1928-29	3,405	976	2,913	1,473	547
1927-28	3,876	1,273	3,013	1,543	628
1926-27	3,405	1,448	2,211	1,918	579
1925-26	3,240	1,179	2,923	1,535	563

Production in Siam, despite poor rainfall in the earlier part of the season in the important central areas, remained, according to the first forecast, higher than that of last year and much above the average.

The countries of deficit

Production in India proper (that is, excluding Burma) has fallen for the third year in succession and the estimated crop of 62,962 million pounds is the smallest since 1927-28. The area sown was 2·6 per cent smaller than in the previous season, decreases having occurred in all the provinces save Bihar and Orissa and the

United Provinces; production rose, however, not only in these two provinces but also in the Central Provinces and Assam. The smallness of the crop was due principally to the fact that the monsoon was rather weak, particularly in August and the early part of September. In Bengal, the principal producing province, the decline in the production of the winter crop, which forms the bulk of the production, was 10·9 per cent from the five-year average though the corresponding decline in area was only 3·4 per cent. Bihar and Orissa, on the other hand, though still 13·6 per cent below average, had a crop 9·2 per cent above that of 1933-34, thanks to an increase of 3·8 per cent in area and to favourable weather in almost all districts. Though the area under rice in Bihar and Orissa is much larger than that in Madras, production has in the last three years been smaller than in the latter province. The crop in Madras underwent a considerable decrease for the second year in succession, drought having been seriously felt in the Deccan. India has thus again a very large deficit to be filled by imports.

Production and net export to foreign countries of India (excluding Burma)

(Million pounds rice and derivatives)

Year	Production				Year	Net export to foreign countries All-India excluding Burma (2)
	All-India excluding Burma (1)	Bengal	Bihar and Orissa	Madras		
1934-35	62,962	20,501	11,670	11,962	1935	...
1933-34	63,910	21,604	10,687	13,226	1934	(3)—167
1932-33	64,933	23,299	10,456	13,455	1933	387
1931-32	71,678	23,627	14,281	13,403	1932	512
1930-31	67,337	22,913	13,975	13,380	1931	479
1929-30	65,074	20,414	14,961	13,079	1930	626
1928-29	67,825	24,103	13,908	12,935	1929	601
1927-28	58,111	16,160	10,896	12,651	1928	272
1926-27	61,147	18,306	11,917	11,802	1927	581
1925-26	64,696	20,454	12,168	13,246	1926	629

(1) The all-India statistics exclude the production of the Punjab, the North-West Frontier Province, Ajmer-Marwara, Manpur Pargana and certain other Indian States, which together produced 2,536 million pounds on the average of the five years ending 1932-33; they also exclude the production of the feudatory states of Bihar and Orissa, for which no reliable data are available. In 1933-34 the production of Bhopal was included for the first time.—(2) *Tel quel*; only a relatively small part consists of rough rice.—(3) Net import.

The crop harvested in China in October is variously reported to have been from one-fifth to one-quarter smaller in some of the most important areas. The failure of the rains in July and August in the Lower Yangtze, the largest and most accessible area of production, is responsible for this. Parts of the other great producing area, in Kwangtung and Fukien, also suffered from drought. Though the carryover of old rice is considerable and secondary food crops are reported to have been good and the winter wheat crop in the Yangtze valley, which is in the transitional zone between the wheat-eating and rice-eating parts of China, is also said to be larger than last year, there will, if the proportion of damage turn out to be really so high, be a large demand for foreign imports of rice into both the Shanghai and Swatow areas. The credit arrangements of rice importers have continued, however, to be dislocated by the large exports of silver consequent on the

difference between the exchange rate of the Shanghai dollar and the price of silver, a difference accentuated by the heavy demand from the United States that followed the Silver Purchase Bill of 19 June 1934. The Chinese Government on 15 October placed a duty on the export of silver plus an equalization charge aimed at making such export unprofitable but high rates of interest in Shanghai continued to hinder the financing of rice imports.

Net imports into the principal Asiatic countries of deficit other than India proper and Japan

(Million pounds rice and derivatives)

Year	China	British Malaya	Ceylon	Netherlands East Indies
1934	1,685	1,025	1,088	573
1933	2,843	982	1,003	752
1932	2,992	921	1,024	890
1931	1,427	1,156	1,006	1,304
1930	2,647	1,329	1,064	1,357
1929	1,439	1,256	1,102	1,592
1928	1,683	1,177	1,093	1,258
1927	2,799	1,228	1,053	1,003
1926	2,489	1,068	1,033	1,293
1925	1,679	907	972	1,110

In British Malaya, where the diminution of dependence on foreign supplies is also being encouraged, the continued extension of the rice area by irrigation and drainage works and the increased use of improved seed appear to have been counterbalanced this season by extensive flood damage in several important producing areas. As consumption is likely to continue to expand, with the improvement in the rubber market, a further increase in import requirements is likely in 1935.

Ceylon also suffered from a prolonged drought in 1934 and the rice crop harvested in February-March of this year was expected be a very poor one and in a few cases even a total failure. A large increase in imports, particularly from Siam, was already noticeable in December in comparison with the same month in 1933 and further heavy imports may be expected before the second crop comes on the market in July 1935.

With the strict regulation of imports and of the trade between their surplus and deficit districts in the last two years and the rapid extension of area the Netherlands East Indies have become a market of more restricted capacity. The area harvested from January to December 1934, together with that remaining to be harvested at the end of December, was rather smaller than the corresponding figure of 1933 and 8 per cent larger than on the average of 1924-33 but in all three sections of Java-East, Middle and West—unit-yields were lower than in any of the previous five years. Production is insufficient for probable requirements and the Government licensed imports from abroad, which began in November.

In the Outer Provinces production prospects were at the end of December on the whole normal.

For the Philippines reports have in the past few months been somewhat contradictory regarding the crop just harvested. While the weather early in the season was favourable, damage by the subsequent typhoon and by insects was suspected to be considerable, while yields in some of the newer areas were likely to be in any case low. When the probable effects of better conditions in the copra market in raising food consumption are also taken into account, the Philippines appear unlikely as yet to suffer from the overproduction that has recently been feared but on the contrary to require at least as much as in recent years to supplement their rice supplies with imports from foreign countries.

THE JAPANESE RICE TRADE

Japan has had a very poor crop, with the exceptionally low figure of 16,327 million pounds rice and derivatives, the smallest crop since 1913-14. This is due to the unfavourable weather, the area sown having been practically the same as last year, while production has fallen 27 per cent. A severe typhoon struck the western part of Hondo in September while drought in Kiushiu and Shikoku and excessive rainfall and insects in other sections caused much damage.

Sources of supply of Japan

(Million pounds rice and derivatives)

Year	Production			Year	Net import of Japan		
	Japan	Chosen	Taiwan		From foreign countries	From Chosen	From Taiwan
1934-35	16,327	...	2,863	1935	...	...	...
1933-34	22,901	5,881	2,634	1934	(1)— 22	2,861	...
1932-33	19,521	5,284	2,822	1933	279	2,295	...
1931-32	17,848	5,131	2,356	1932	235	2,181	952
1930-31	21,617	6,200	2,321	1931	(1)— 137	2,659	765
1929-30	19,252	4,429	2,041	1930	273	1,470	531
1928-29	19,493	4,368	2,140	1929	395	1,632	568
1927-28	20,074	5,592	2,173	1928	496	2,050	609
1926-27	17,970	4,946	1,957	1927	1,278	1,643	685
1925-26	19,299	4,775	2,029	1926	748	1,661	621

1) Net export.

In Chosen there was a decrease of 5·3 per cent in area from the rather high figure of 1933-34 and, though temperatures and rainfall in June and July favoured transplanting, there was subsequently considerable damage by drought and floods in the south of the peninsula. In Taiwan, on the other hand, a new record of production has been attained, despite drought damage to the second crop in the northern sections. Given the very small crop in Japan and the likelihood of a smaller crop in Chosen, the heavy carryover of old crop rice on 1 November 1934, of which about three-quarters were in the hands of the Japanese Government, will be largely absorbed in the current season ; the amount

of the decrease in production is, in fact, greater than the total carryover of old crop, which was about one-fifth of the normal annual consumption of Japan.

The general situation in the competitive markets

Burma's export surplus is estimated at 7,175 million pounds of rice and derivatives, a decrease of 1,524 million on the 8,699 million pounds actually exported from last season's crop. Such a decrease corresponds to the decrease in the production. Crop movement in the first two months of the year was even more rapid than in the corresponding period of last year. Exports to India were about one-third larger than in the corresponding period of 1934 while increases in exports were also registered to China, the Netherlands East Indies and the Straits and, to a less extent, to Ceylon. Given the still smaller crop in India, an even larger proportion of the total exports of Burma is likely to be absorbed in that market than in 1934, when the proportion was 66 per cent. This year the natural advantage of proximity will be reinforced not only by the currency advantage (as against French Indo-China) but by the proposed import duty of 12 annas per maund (1*s.* 6*d.* per cwt.) to be imposed up to 31 March 1936 on all imports of foreign brokens, a measure introduced in response to the large imports of cheap low-quality foreign rice, especially from Siam, aided by reduced freight rates, but also from French Indo-China in the past year. It may be expected therefore, that there will this year be still less Burma rice available for foreign markets than in 1934.

In the absence of later estimates and, in the case of the exporting countries of French Indo-China, of any estimates at all, it must be assumed, on the basis of crop condition reports and on such statistical data as is available, that production in French Indo-China and Siam is average. For French Indo-China the export surplus will in all probability be below the high figure of 3,253 million pounds actually exported in 1934. The metropolitan market, which consumes the rice almost entirely for stock-feeding and to a much less extent, for industrial purposes, takes not far below half of the total export and has steadily increased its absorption in the last five years. Import quotas for foreign rice and an increase in import duties favoured Indo-China in 1934. On the other hand, the large quantities of wheat available for feeding limit the possibilities of absorbing larger proportions of rice and in the early part of this year seriously reduced the imports. In the other markets, Saïgon rice is consumed as food, largely in mixtures with rice of other origins. The most important foreign market is China, which in 1934 was followed by India, the Straits and Cuba, to all of these unless China there was an increase. The export to India, which was exceptionally high last year, is likely to be checked by the proposed new duty. On the other hand, the large requirements of Eastern countries, together with the large quantities of feeding wheat on the French market and the bounty of 15 francs a quintal now given

by the French Government to exports of Indo-Chinese rice to other markets than France may result in a very considerable diversion of Saïgon rice to China and other Eastern markets.

In Siam the first estimate of surplus available for export is 4,194 million pounds, slightly less than the actual exports of 1934. In the first three months of the export season, up to the end of February, exports showed an increase of 40 per cent, rises being particularly notable to the Straits, China and the Netherlands East Indies. There has been a steady increase in the last few years in the exports to the Straits, in which the preference of the Chinese population for Siam "field" types is a strong point in Siam's favour. With the continued large requirements of India for Burma rice, by far the chief rival of Siam in the Straits, Siam's position in the latter market is likely to be as strong as ever in 1935. The reopening of the Netherlands East Indies to foreign imports, which had begun to make itself felt in the last quarter of 1934, and, still more, the shortage in Ceylon, are likely to more than compensate for the effects of the probable import duty in India. Last year the share of Siam in Ceylon's imports almost trebled and rose from 9 per cent to 22 per cent partly because of the relatively great reduction in the prices of Siam rice and partly because of the small production in India, which decreased available supplies from both Burma and that country. Siam rice has in the last three years made great progress in Cuba but this remains a secondary market. Even on the supposition that Japan again takes Siam rice this year, following on the smaller production in Japanese territories, the bulk of Siamese exports will, however, be directed to the Chinese market.

Imports into China

(Million pounds rice and derivatives)

——	1934	1933	1932	1931	1930	1929
French Indo-China . .	755	1,249	1,010	118	438	169
Siam	761	1,007	858	94	60	83
Burma and India . .	141	560	956	183	1,268	96
Hongkong . . .	29	25	153	915	803	1,065
Gross total . . .	1,700	2,856	2,998	1,431	2,651	1,443

In the official statistics the imports are *tel quel* but as the great bulk is white rice they may be taken as roughly equivalent to rice and derivatives.

In the last four years Siam has gained on French Indo-China in the Chinese market, Burma taking a large share only in years when the capacity of India to absorb outside supplies is small and prices are low. China's demand is mainly for Saïgon and Siam brokens, while as regards whole rice the cheaper grades of Siam Garden have recently been gaining on Saïgon No. 1 Long. This year the poor crop in China, the situation in the French market and the large requirements of other markets should together result in an easy absorption of the surplus,

together with a regaining of lost ground by French Indo-China. Movement from both sources was rapid in the first months of the year, and about equally divided. The total import of China in January was almost four times as great as in the same month last year.

In Europe, which takes Oriental rices mainly for industrial and feed purposes, Germany, the Netherlands and the United Kingdom are the principal markets apart from France, which takes very little save that produced in its own possessions. Competition of Oriental rices in the other three large markets is principally between Burma and Siam. Germany's imports of milled rice were reduced by about one-half in 1934, the Government wishing to encourage milling within the country and protect home-grown feeds. The import of rice bran was practically stopped by a heavy surcharge. Although there was an increase in the import of rough rice, of which about four-fifths is drawn from Burma, most of the difference was absorbed by Italian rice for human consumption, the German Government having made an agreement with the Ente Nazionale Risi to take a greatly increased import from Italy.

The Netherlands, which import rough rice mainly from Burma and Japan and very little milled rice from the East, increased their imports of the former in 1934.

Total imports of whole rice into the United Kingdom were higher in 1934 than in the previous year, though below the 1932 level. Imports from Burma increased, thanks to the preferential duty. For brokens and mixtures of whole and broken rice, on the other hand, French Indo-China and other foreign countries showed a great gain, while Burma fell, the total import being only a little higher. The large supplies of feeding wheat in the French market may result in still larger amounts of brokens from French Indo-China coming on the United Kingdom market.

The general outlook

World production in 1934-35 has been very small. The decline has been principally in the countries that have normally the largest deficits, India, Japan and very possibly China. The importing countries of the second order—British Malaya, Ceylon and the Netherlands East Indies—also appear to have had small crops.

On the other hand the principal exporting countries, except for Taiwan, have had crops not above average and in the case of Burma and probably Chosen

well below average. In the first months of the commercial season demand has been very active and exports from Burma, French Indo-China and Siam have been large.

Burma will, as last year, profit by the shortage in India. Japan will at any rate be able to absorb a large part of its heavy carryover. While rising prices may to some extent act as a check on consumption, demand is likely to be active and general in the other importing countries during the coming months and not only the surplus of Burma after India's demands have been satisfied but the surpluses of Siam and French Indo-China should be marketed without difficulty. Prices are likely to maintain an upward tendency.

RAISING DAIRY CALVES ON A LIMITED AMOUNT OF WHOLE MILK

BY

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On farms where cream is sold and skim-milk is available the rearing of calves presents little difficulty. The case is different, however, where farmers are selling whole milk in towns or to cheese factories. Under these conditions many dairymen consider it uneconomical to rear the calves because of the relatively high value of the milk.

Extensive investigations into the raising of calves without milk have been carried out in overseas countries. Although certain calf meals and milk substitutes have given fairly satisfactory results, it is now generally admitted that there is no satisfactory substitute for whole milk in the ration of young calves and that some whole milk must be fed for a while to give the calf a good start if satisfactory growth is to be made.

When rearing calves on a limited amount of whole milk the method usually followed is to give the calf a good start on whole milk for six to ten weeks only and then to rely on a suitable ration of concentrates and hay.

Review of literature.—The literature on the subject is scattered and very extensive. Overseas workers such as Humphrey and Hulce [1916], Hulce and Nevens [1917], Hulce, Morrison and Humphrey [1923] and others all report that calves made satisfactory growth when raised on a total of approximately 400 lbs. of whole milk, fed over a period of from 50 to 70 days, and supplemented by liberal amounts of both legume hay and suitable concentrate mixtures. In South Africa, however, these rations have not proved satisfactory in the past. [Wande, 1929 and Murray, 1927-1930].

PLAN OF EXPERIMENT

In view of the unsatisfactory results obtained in previous trials by the writer and others in South Africa more whole milk was fed in the first of the two experiments reported on here than would seem necessary judging by the results of the overseas investigations. In the second experiment the amount of milk fed was based on the results of the first experiment.

Calves used.—The calves used in both experiments were by a good pure-bred Ayrshire bull out of Grade Friesland cows.

Feeding and management.—The calves were usually left with their dams for the first day only and then taken away and started in the experiment. Throughout the experiment they were fed separately in small pens and allowed out together for exercise in a small one-acre paddock. Each pen was fitted with a hay rack and a small manger. The milk and concentrates were fed twice daily and the calves had free access at all times to good quality lucerne hay in their racks. From the second week on they were encouraged to eat as much concentrates as possible, but during the fifth and sixth months the allowance of grain was limited to 5 lbs. each per day. The concentrates were fed dry.

To get more accurate information on the efficiency of the two ration the calves were not allowed any grazing.

Records kept.—A few hours after birth and thereafter at 30 day intervals, individual weight and height measurements were taken of the calves. The method followed was that of Eckles [1920, p. 5].

Individual records were also kept of the amounts of hay and concentrates consumed and of the general observations made during the course of the experiment.

As the "normal growth" of Ayrshire $\times$ Grade Friesland calves is not known it was decided to use, as a basis of comparison, Eckles' [1920, pp. 8 and 11] normal growth data for pure bred Frieslands (Holstein's), although it is realised that such a comparison is not altogether justified. In addition to this standard of comparison the views of outside cattlemen of experience were obtained on the thriftiness, growth and development of the calves for age at the conclusion of the experiments.

EXPERIMENT 1

Experiment 1 was carried out during the period 1st July 1931 to 19th January 1932. The five calves were born between the 1st and 23rd July 1931.

Ration fed.—The calves were fed milk twice daily according to the following schedule :—

Period in days	Period in weeks	Whole milk per calf per day
		pints
1st day with dam	..	..
2nd day dam's milk	1st	4
3rd to 7th day dam's milk	..	6
8th to 14th day whole milk	2nd	8
15th to 21st ,, ,,	3rd	10
22nd to 28th ,, ,,	4th	10
29th to 35th ,, ,,	5th	12
36th to 42nd ,, ,,	6th	10
43rd to 49th ,, ,,	7th	8
50th to 56th ,, ,,	8th	6
57th to 63rd ,, ,,	9th	4
64th to 70th ,, ,,	10th	2
71st to 180th ,, ,,	11th to 26th	0

Each calf, therefore, received 655 lbs. of whole milk or 635 lbs. of saleable milk.

The following concentrate mixture was fed dry :—

150 lbs. maize meal.
50 lbs. bran.
50 lbs. peanut meal (52 per cent Cr. Prot.)
25 lbs. bloodmeal (72 per cent Cr. Prot.).
5 lbs. di-calcium phosphate.
5 lbs. salt.

Experimental Results

TABLE I

Record of growth from birth to 180 days

—	Calf No. 8	Calf No. 9	Calf No. 10	Calf No. 11	Calf No. 33	Average	Normal*
Weight at birth, lbs.	90	80	84	102	75	86	90
Per cent normal weight	100	89	93	113	83	96	..
Weight at 180 days, lbs.	410	395	270†	400	332	384	349
Per cent normal weight	117	113	89	115	95	110	..
Height at birth, ins.	28·8	27·8	29·0	30·3	28·0	28·8	28·3
Per cent normal height	102	98	102	107	99	102	..
Height at 180 days, ins.	41·3	39·4	39·1†	41·2	38·9	40·2	39·7
Per cent normal height	104	99	103	104	98	101	..

*Eckles' (1920) normal growth data pure bred Frieslands (Holsteins).

† On the first day of the 6th month calf No. 10 got sick and was removed from the experiment. It died a few days later from anaplasmosis. Data are therefore available only up to 150 days of age for this calf.

Growth of calves.—From Table I it will be noticed that although the weights of some of the calves were below normal at birth all were normal as regards height.

The growth made by the calves up to the age of 180 days (150 days for calf No. 10) was very satisfactory. The average weight at this age was 110 per cent normal and height 100 per cent normal.

Fig. I shows that the increase in weight was above normal and improved from birth to 180 days. In height (see Fig. II) there was no similar corresponding increase in rate of growth. In this respect, however, the calves grew normally throughout, never varying more than 1 per cent above or below normal.

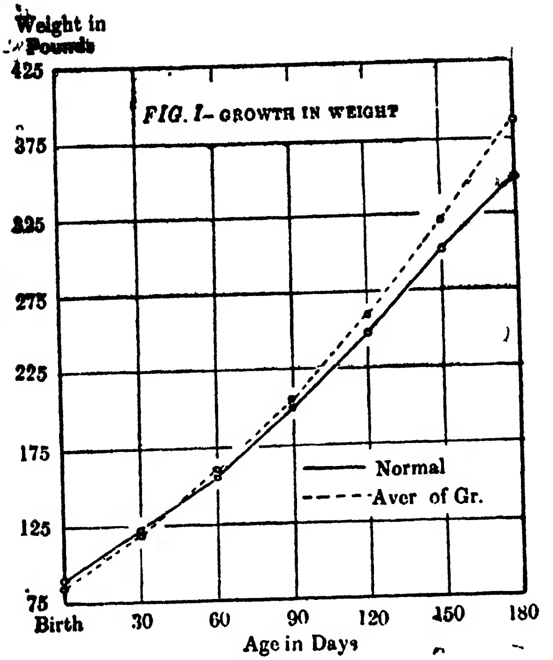


FIG. I—GROWTH IN WEIGHT

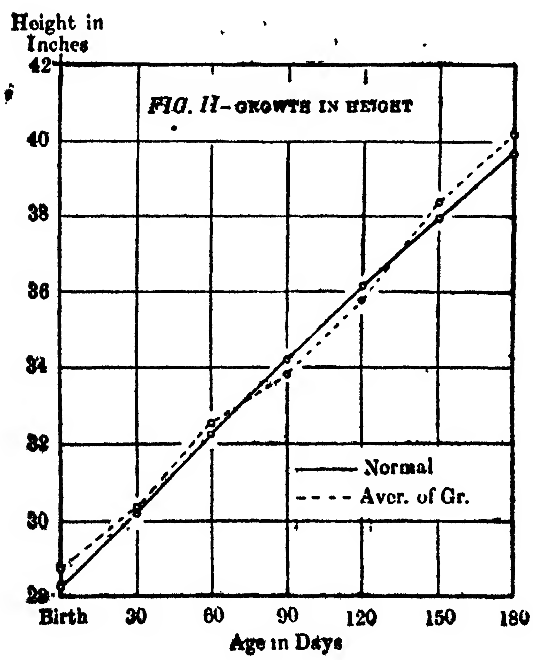


FIG. II—GROWTH IN HEIGHT

Throughout the experiment the calves had a very thrifty appearance. They were very favourably commented on by several cattlemen as regards their condition, thriftiness and general appearance.

TABLE II

Average monthly consumption of concentrates and hay per calf (1)

Month	Concentrates lbs.	Hay lbs.
1st	10	7
2nd	40	25
3rd	80	60
4th	104	73
5th	138	88
6th	160	103

(1) Average figures for four calves only.

TABLE III

*Average amount of feed consumed and feed cost per calf up to 180 days of age**

Whole milk from 5 days of age	Concentrates	Hay	Feed cost per calf†
635 lbs.	532 lbs.	356 lbs.	£3 4 0

* Average figures given for four calves only. Calf No. 10 consumed 422 lbs. of concentrates and 286 lbs. of hay up to 150 days of age.

† Whole milk, 6*d*. per gallon ; lucerne hay, £2 ; maize meal, £5 ; peanut meal, £7 10*s*. ; bran, £6 ; bloodmeal, £8 ; di-calcium phosphate, £15 ; salt, £3 10*s*. 0*d*. per ton.

The amount of concentrates consumed per calf is in keeping with the results of overseas investigations, but the consumption of hay is slightly low.

The total feed cost amounted to £3 4*s*. 0*d*. per calf. This cannot be considered excessive. Of the total feed cost the milk accounted for 50 per cent and the concentrates and hay for 50 per cent.

Summary

During a period of 180 days the Ayrshire × Grade Friesland calves in the experiment each consumed a total of 635 lbs. of whole milk, 532 lbs. of concentrates and 356 lbs. of hay. The whole milk was fed from the 5th to the 70th day.

The ration proved very satisfactory from a growth point of view. The average weight and height of the calves at 180 days of age were 110 per cent and 100 per cent normal respectively.

The cost of feed amounted to £3 4*s.* 0*d.* per calf. The whole milk accounted for 50 per cent and the concentrates and hay for 50 per cent of the feed costs.

Experiment 2

From the results of Experiment 1 it will be clear that, if the whole milk part of the ration could be reduced without loss of efficiency, the feed costs per calf would be reduced considerably. The object of Experiment 2 was, therefore, to investigate the possibility of rearing calves successfully on a smaller allowance of whole milk than was fed in Experiment 1.

Experiment 2 was carried out during the period 22nd October 1932 to 30th May 1933. Seven calves, born between the 22nd October and 30th November 1932, were used.

Rations fed.—Whole milk was fed twice daily according to the following schedule :—

Period in days	Period in weeks	Whole milk per calf per day
		pints
1st day with dam	..	..
2nd day dam's milk	1st	4
3rd to 4th day dam's milk	..	6
5th to 7th day whole milk	..	6
8th to 14th day whole milk	2nd	8
15th to 21st ,, ,,	3rd	10
22nd to 28th ,, ,,	4th	8
29th to 35th ,, ,,	5th	6
36th to 42nd ,, ,,	6th	6
43rd to 49th ,, ,,	7th	4
50th to 56th ,, ,,	8th	2
57th to 180th ,, ,,	9th to 26th	0

Each calf, therefore, received a total of 428 lbs. of whole milk, or 408 lbs. of saleable milk.

The roughage and concentrate rations were the same as those fed in Experiment 1, *viz.*, lucerne hay and the following concentrate mixture :—

150 lbs. maize meal.
50 lbs. bran.
50 lbs. peanut meal.
25 lbs. bloodmeal.
5 lbs. di-calcium phosphate.
5 lbs. salt.

Experimental Results

TABLE IV

Record of growth from birth to 180 days

—	Calf No. 60	Calf No. 61	Calf No. 82	Calf No. 62	Calf No. 63*	Calf No. 16	Calf No. 64	Average	Normal†
Weight at birth, lbs.	73	86	74	74	75	85	80	78·1	90
Per cent normal weight	81	96	82	82	83	94	89	87	...
Weight at 180 days, lbs.	300	315	315	290	265	315	320	302·9	349
Per cent normal weight	86	90	90	83	76	90	92	87	...
Height at birth, ins.	26·6	28·5	28·6	28·3	28·8	27·8	27·3	28·0	28·3
Per cent normal height	94	101	101	100	102	98	97	99	...
Height at 180 days, ins.	37·2	38·1	38·3	38·8	37·3	37·8	37·2	37·8	39·7
Per cent normal height	94	96	97	98	94	95	94	95	...

* Suffered from anaplasmosis during 4th and 5th months.

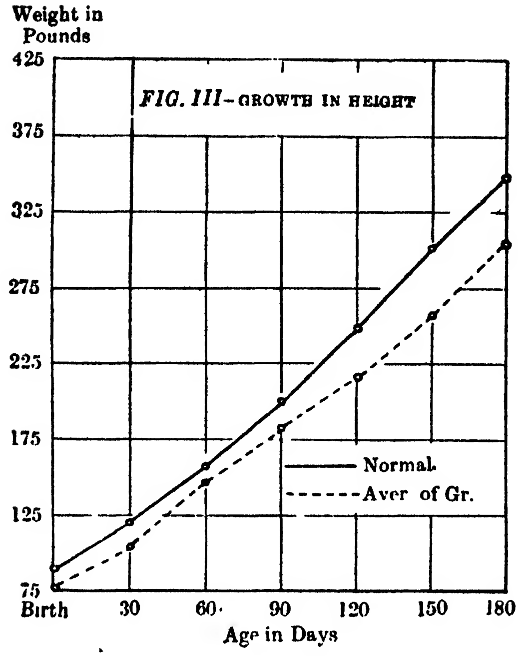
† Eckles' (1920) normal growth data for pure bred Frieslands (Holsteins).

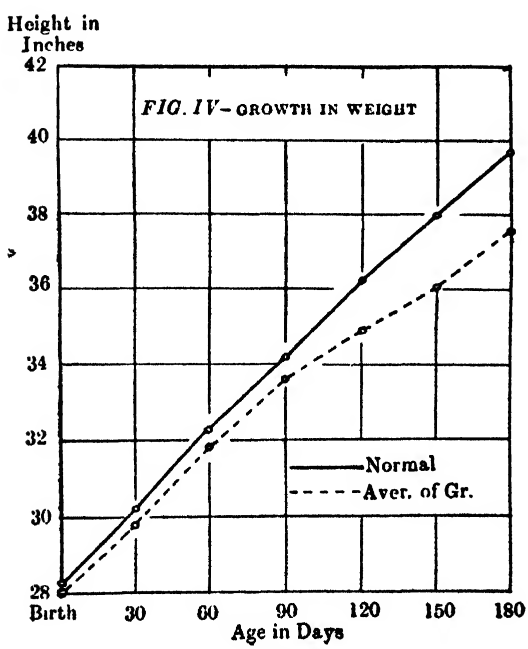
Growth of calves.—It will be seen from the individual birth weights and heights of the calves that they were on the whole smaller than those used in Experiment 1.

The average weight at birth was 78·1 lbs. (87 per cent N.) and at 180 days of age 303 lbs. (87 per cent N.) and, while the calves were practically normal as regards height at the commencement of the experiment, their average height at 180 days of age was 37·8 inches (95 per cent N.).

The growth data show, therefore, that the calves were not as well developed at the conclusion of the trial as those in Experiment 1.

From Figs. III and IV it will be noticed that, taking into consideration their smaller size at birth compared with the Experiment 1 calves, satisfactory growth was made during the first 90 days of the experiment. During the last 90 days, however, there was a definite decrease in rate of growth both in weight and in height. This decrease was due to the fact that after the feeding of whole milk was discontinued, great difficulty was experienced in getting the calves to eat sufficient concentrates (see Table V). In addition calf No. 63 suffered from a mild attack of anaplasmosis during the 4th and 5th months of the experiment.


Weight in Pounds
425
375
325
275
225
175
125
75
Birth
30
60
90
120
150
180
Age in Days
FIG. III—GROWTH IN HEIGHT
Normal
Aver of Gr.


Height in Inches
42
40
38
36
34
32
30
28
Birth
30
60
90
120
150
180
Age in Days
FIG. IV—GROWTH IN WEIGHT
Normal
Aver. of Gr.

Although the calves apparently did not make normal growth when compared with Eckles' normal growth data and did not do as well as the Experiment 1 calves, they had a sleek, thrifty appearance at the conclusion of the experiment, and were considered well grown for their ages by experienced cattlemen. Their development since the conclusion of the trial has shown that they will grow into as satisfactory cows as the Experiment 1 calves.

TABLE V

Average monthly consumption of concentrates and hay

Month	Concentrates lbs.	Hay lbs.
1st	9	13
2nd	37	55
3rd	74	110
4th	81	136
5th	111	158
6th	138	177

TABLE VI

Average amount of feed consumed and feed cost per calf up to 180 days of age.

Whole milk from 5 days of age	Concentrates	Hay	Feed cost per calf *
408 lbs.	450 lbs.	649 lbs.	£2 10 6

* Whole milk 6d. per gallon; lucerne hay, £2; maize meal, £5; peanut meal, £7 10s.; bran, £6; bloodmeal, £8; di-calcium phosphate, £15; salt, £3 10s. 0d. per ton.

From Table VI it will be noticed that the calves consumed on the average 408 lbs. of whole milk, 450 lbs. of concentrates and 649 lbs. of hay. The consumption of concentrates is definitely low and, as pointed out previously, is no doubt partly responsible for the slower growth during the last three months of the experiment. The calves consumed on the average 227 lbs. milk and 82 lbs. concentrates less and 293 lbs. hay more than the Experiment 1 calves.

In view of the fact that satisfactory growth was made during the first 90 days of the experiment it is considered that the milk allowance (408 lbs.) was adequate and the schedule followed satisfactory.

The total feed cost per calf up to 180 days of age was £2 10*s*. 6*d*., and of this amount the whole milk accounted for 40 per cent and the concentrates and hay for 60 per cent. These costs should be considered very low.

Summary

During a period of 180 days the Ayrshire × Grade Friesland calves in Experiment 2 consumed a total of 408 lbs. of whole milk, 450 lbs. of concentrates and 649 lbs. of hay. The whole milk was fed from the 5th to the 56th day.

The ration proved satisfactory from a growth point of view.

The feed cost per calf amounted to £2 10*s*. 6*d*., and of this amount the whole milk accounted for 40 per cent and the concentrates and hay for 60 per cent.

From the practical point of view the ration fed to the calves in Experiment 2 proved efficient and considerably more economical than that fed in Experiment 1. A saving of 13*s*. 6*d*. per calf was effected.

Acknowledgments.—I am indebted to Dr. D. G. Haylett, Director of the Matopo School of Agriculture for providing the necessary facilities for carrying out the experiments; to Dr. A. E. Romyn, Chief Animal Husbandry Officer, for technical advice and assistance throughout the experiments and assistance with the preparation of this report; to Mr. R. H. Greaves, Stockman, for regularly weighing and measuring the animals and supervising the feeding.

REFERENCES

Bender, C. B.; Perry, E. J, (1929).—'The New Jersey Dry Fed Calf Mixture.' *New Jersey Agr. Ext. Bul.* 73.

Eckles, C. H. (1920).—'The Normal Growth of Dairy Cattle'. *Missouri Agr. Exp. Sta. Res. Bul.* 36.

———; Gullickson, T. W. (1924).—'Raising the Dairy Calf when Whole Milk is sold.' *Minnesota Agr. Exp. Sta. Bul.* 215.

——— (1927).—'Dairy Cattle and Milk Production.' The Macmillan Co., London, p. 265.

Fraser, W. J.; Brand, R. E. (1913).—'Milk Required to Raise a Dairy Calf.' *Illinois Agr. Exp. Sta. Bul.* 164.

Hulce, R. S.; Nevens (1917).—*Illinois Agr. Exp. Sta. Circ.* 202.

Morrison, F. B.; Humphrey, G. C. (1923).—'Economic Rations for Dairy Calves.' *Amer. Soc. Animal Prod. Proc.*, pp. 75-78.

Humphrey, G. C.; Hulce, R. S. (1910).—'Raising Better Dairy Calves'. *Wisconsin Agr. Exp. Sta. Circ.* 59.

Jones, I. R.; Brandt, P. M.; Wilson, F. D. (1931).—' Raising Dairy Calves on Dry Meals '. *Oregon Agr. Exp. Sta. Bul.* 290.

Mead, S. W.; Regan, W. M.; Bartlett, J. W. (1924).—' A Study of Factors Affecting the Growth of Dairy Heifers'. *J. Dairy Sci.* V. 7, pp. 440-459.

Murray, C. A. (1927-1930).—Unpublished data, Dept. of Agriculture, Union of South Africa.

———— (1929).—' Report on Calf-Feeding Experiments conducted at the Potcheptroom School of Agriculture.' First Triennial Conference, Proc. Dept. of Agric., Union of South Africa.

Rupel, I. W. (1929).—' Raising the Dairy Calf.' *Wisconsin Agr. Exp. Sta. Bul.* 404.

Savage, E. S.; Tailby, G. W. (1909).—' Substitutes for Skim-milk in Raising Calves '. *Cornell Agr. Exp. Sta. Bul.* 269.

———— (1911).—' Substitutes for Skim-milk in Raising Calves: With Supplement Showing later Development.' *Cornell Agr. Exp. Sta. Bul.* 304.

Swett, W. W. (1919).—' Raising Calves on Farms where Whole Milk is Sold.' *Missouri Agr. Exp. Sta. Circ.* 88.

Wande, A. F. (1929).—' Hand Rearing of Dairy Calves.' *Union of South Africa, Dept. of Agric. Bul.* 39, pp. 3-12.

PAMPAS GRASS AS WINTER COW-FEED

BY

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In this *Journal* for October, 1932, was given some account of the successful utilization of the tall South American plume grass known as pampas grass (*Gynerium* (*Cortaderia*) *argenteum*), universally grown as an ornament in gardens where it produces tall dense tussocks which, including the flowering stalk and plume, attain a height of 10 ft. to 12 ft. When grown in gardens the mass of material produced in the course of years presents a bulk of herbage which would not impress any one, least of all a dairy-farmer, as being likely to prove an attractive feed for cows, the persistent dead leaves of the tussock mixed with the tall coarse leaves showing a dry innutritious-looking mass. When, however, dead or old leaves are prevented from accumulating by firing every year after cattle have eaten down the succulent green portions and some of the dead leaves also the subsequent growth is tender and easily grazed by cows. Knowing that this material grows at the rate of a foot a month and produces per acre 50 tons of green edible matter of higher dry-matter content than turnips or mangels, that it will be greedily eaten by cows in the winter, that it cannot spoil with bad weather (drought, heavy rains, or gales), that it requires no weeding, no cultivation, and no fertilizer and hardly any attention after once planting, the rapid growth of green succulent leaves is impressive in the extreme. The clumps will grow on any kind of soil and, when possible, throw down roots to a depth of 8 feet below the surface, which enables the giant tussock to search over a large area for the plant food and water which it requires. One can easily imagine the average dairy-farmer being sceptical as to the good news and looking for the catch in the system which in the Northern lands, at least, does away to some extent with the laborious hay and silage making and root-growing. The method is being thoroughly tested by independent farmers in the Waikato and Mr. McClean is distributing roots of the grass as far south as Wellington. Arrangements are being made to test the use of this grass on the pumice lands where it grows vigorously and where it can have such a good root-run in that deep permeable soil.

In spite of the sometimes pathetic attempts of cattle to get at pampas and devour it, these attempts have been disregarded as evidence that it might be desirable to cultivate if for food purposes, in spite also of the advice of two eminent men—Sir George Grey and Dr. Curle—who seemed to anticipate its future value. One observer tells how cows will lie down on their sides in an evdeavour to get their heads under the bottom wire of a fence to eat the pampas, often destroying fences in their attempts to get at this favourite fodder. When this happened the farmer merely strengthened his fences, shutting his eyes to the value of such evidence. One farmer, Mr. George Short, of Dargaville, writes that twenty-two years ago he had his first experience of pampas, and since then he has always grown it for shelter and stock-food for in winter all stock are fond of it, breaking down good fences to get at it. He has grown it on drain banks, in paddocks, and on hill land. It grows as well on poor gum land as it does on good swamp land. It would be a great asset to exposed farms near the coast where other shelter cannot thrive owing to salt winds. Mr. Short has not grown it for fodder alone, but knows its value as stock-food. He sends photos of hedges he planted at Turiwiri, Northern Wairoa, one of the oldest of which is six years old and 10 ft. high and shows signs of being well grazed as far as cattle can reach.

To Mr. Alec McClean, of Waitakaruru, Hauraki Plains, must, however be given the great credit of being the first to profit adequately from his observations that cattle are inordinately fond of pampas in the autumn, by systematically planting and using it as winter feed as described in the previous article. Since then, Mr. McClean has extended his plantations and has continued to use pampas systematically as winter food and has answered all inquiries which have come from both local and overseas farmers. He has willingly received and explained to deputations of agriculturists, chemists, veterinarians, pressmen, and other farmers his method. He has also supplied at a nominal price, roots to those desiring to make experiments. Success has not come to Mr. McClean without perseverence in the face of many obstacles. Without knowing any of the previous opinions or work of others with pampas, and without any official guidance and advice, and, as he puts it, in the face of all sorts of discouragement and carping criticism which required quite a lot of determination to disregard, he has demonstrated beyond doubt that a new fodder plant is available which is destined, it is thought, to have very far reaching effects in cheapening production in every branch of cattle-farming.

Being a grass, this new fodder is particularly suitable for balancing the diet of cattle when the tendency is for the protein of the natural diet, pasture, to rise to excess of requirements as exhibited by many high fertility pastures in late summer and autumn when clovers often predominate to such an extent that the pasture presents the appearance of a clover ley. Green maize is often used as a summer supplementary soiling crop for dairy-cattle, but the production of green maize is expensive, considering that the plants only last one season and require preparation

of the soil, manuring, and finally carting of the crop, all involving labour and expense, whereas pampas is a perennial crop which can be grazed *in situ*, and will smother all competing weeds. The charge made for the roots is £1 10*s*. per 100 f.o.r., so that the cost for an acre is £15, and two years from the date of planting, as well as in subsequent years, it will support with suitable run-off over fifty head of mature stock for ten weeks, so that, viewed as an investment, the plantation of 1 acre of pampas is an eminently payable proposition.

The writer does not advise farmers to go to the expense of buying enough plants for an acre until they have tested the matter on a small scale. In gardens this plant is apt to outgrow its welcome and when once a clump has established itself in a garden it requires considerable effort to eradicate or even reduce it. Hence any farmer desiring plants has only to ask his friends who will probably be glad to give him permission to take as much as he wants, but this will be a strong man's job.

Pampas does not appear to spread from seeds in the southern portions of the North Island, but in the Auckland and North Auckland districts it is regenerating rapidly by this method, especially on railway enclosures and waste lands. It is readily distinguished from toetoe by the stouter, taller habit and denser plumes.

The result of pampas feeding on Mr. McClean's own cattle has been the subject of investigation by competent visitors who have expressed their appreciation of the condition of the stock on the farm. Although milking what is called "a very ordinary herd," mostly Jerseys, he is topping his district against all suppliers for amount of butterfat per cow per month, which is shown by the factory returns, although many of his neighbours have well-bred stock with high butterfat records. Mr. McClean's results are all the more remarkable as no top-dressing is done on his farm. The soil is not excessively moist in Ngatea and in summer months it becomes decidedly dry. The soil is peaty, the subsoil being a rich clay. For further information of the Hauraki Plains soils see *the New Zealand Journal of Agriculture*, June, 1914.

Mr. C. R. Taylor (country assistant to the Chemistry Section at Rotorua), with a view to determine the value of pampas in the pumice lands, met Mr. McClean at Rotorua and at his request afterwards visited his farm at a time when the pampas feeding was in full swing—August, 1933—a previous visit having been made in midsummer. His stock are in wonderful condition and attack the giant tussocks with evident relish, which is not the result of undue starvation but the palatableness of the pampas. Nothing appears to be wasted, as the stock eat the tufts almost to the ground including some of the dried-up material—even the plumes.

Mr. McClean's method of laying out his plantations is simple and efficient. An area 1 to 2 chains wide and several chains in length is planted in the spring with pampas roots 6 ft. apart which provides approximately one thousand plants to the

acre. These are not fed off until the second year, by which time the estimated yield of green material per plant is, roughly, one cwt. or 50 tons to the acre. This figure, so far as weight is concerned, compares more than favourably with the yield of the average swede crop as grown in New Zealand. In dry matter the pampas is much richer than swede or mangel. During the winter ending September 1932, Mr. McClean wintered 106 head of grown stock on 2 acres of pampas with only a 40-acre run-off paddock. This gives some idea of the great ultimate winter carrying-capacity of his 200-acre farm when the whole 10 acres of pampas now being grown is ready to feed off. It is considered that it will not be necessary to grow more than 10 acres for winter feed when the farm is fully developed and stocked to capacity.

During the past winter Mr. McClean has fed 130 head of grown stock and 70 head of young stock on 2 acres of pampas with a run-off of 48 acres. Feeding-off was commenced on the 14th June, 1933, and finished on the 20th August, a period, approximately, of ten weeks. Reckoning two thousand plants to the 2 acres, this provides two hundred plants per week for 130 head, or, roughly, one and two-fifths tussocks per beast per week. Allowing 1 cwt. of green material per plant, each animal will consume 160 lb. of green material per week in addition to that obtained from the pasture run-off. Under the conditions obtaining at Waitakaruru (latitude 37 degrees south), this amount of supplementary fodder appears sufficient to maintain stock in good healthy condition. In more rigorous climates one would expect a greater consumption to be required to produce the same results. The method by which the cow with its soft mouth is able to demolish and graze these tall sedge-like growths varies with the individual. Some animals favour pulling the canes from the base while others take hold of the leaves almost at the tips. Either method appears to be equally easy to stock and causes them no inconvenience whatever. Next year there will be available on this farm from 8 to 10 acres of pampas, some of which will be reserved for an experiment in summer feeding. The proper time to plant pampas is at the beginning of spring or after the worst of the frosts are over. Frost undoubtedly cuts back an inch or two of the tender young growth, but not sufficient to do material harm to the plant. New plants are obtained by sub-division of old matured clumps into single shoots with just a little of the root attached. A sharp-edged spade makes a useful instrument for cutting out new plants from old tufts. No particular care or skill appears necessary in planting new areas so long as the right season is chosen. New plantations should be allowed to grow and develop until their second year from planting after which they may be grazed regularly either in winter or summer as may be most expedient. Following the feeding-off in breaks the whole of the residue left by the stock consisting of dry mounds of dead leaves if fired, which clears up all the wasted material tramped under foot and neglected by the stock and reduces the tufts to a reasonable size. Firing appears to favour the subsequent development of a more luxuriant growth which may be partly explained by the

fertilizing effect of the ash. Mr. McClean's methods and stock were carefully examined by Mr. C. R. Taylor from whom and from the owner himself the writer derives his information, and could find nothing to which he could take exception. Mr. McClean's revolutionary practice is certainly giving excellent results at present and there is not the slightest evidence that might indicate any ill-effects to the cattle from grazing as a supplementary fodder such an apparently rank material as pampas grass. The fibre is very short in the grain and the leaves readily break up into the smallest pieces.

Perhaps the feeding of pampas may be extended to cover supplementary requirements of early spring when stock tend to scour, for which it is an antidote if similar in action to tootoe (Goldie), and late summer when the pasture tends to be overloaded with clovers and therefore requires balancing with a diet less rich in protein and still palatable, which pampas certainly is. The feeding of excess of protein is wasteful and, some authorities hold, injurious. (see *the New Zealand Journal of Agriculture*, February, 1929, p. 97).

Droughty summers are not unknown in the North Island dairying districts, when the pastures dry up and the cattle suffer. It is easy to see that such a drought resistant grass as pampas is likely to be a good insurance against the ill effects of food shortage on a valuable herd as a time when other supplementary fodder is not available.

Conclusions

Pampas grass grows at the rate of a foot or more a month from the divided root-stocks when planted out in the paddocks, and one thousand plants may be set in an acre of ground. In from eighteen months to two years these plants may be fed off in breaks which yield 50 tons of green matter to the acre. Cattle are very fond of the plants in their second year, and even ordinary grade cows improve in condition and give an increased butterfat test immediately they commence grazing this new fodder, the rise in the test being as much as 0·3 per cent, which is lost if the cows are taken off the pampas. Cow remaining on pasture as a control show no increase. This is the result of two years experience. Pampas tussock, if to be used for grazing, should not be fed off later than the second year; if left until the third year, although better for shelter, they are more difficult to graze. After the first year's grazing the tussocks may be grazed regularly every year. After the plantation is eaten down it is cleaned up by fire to destroy the dead rubbish. In a few days may be seen emerging from the charred remains of the pampas tussock many green shoots which grow so rapidly that in six months they may reach 7 ft. in height.

Compared with ordinary pasture grass, which has 75 per cent; pampas only contains 70 per cent, of water, while turnips contain 90 per cent. Hence pampas is rich in dry matter compared with other green fodders.

Mr. C. R. Taylor in going through the pumice country has taken the opportunity of inspecting shelter-belts of pampas, and finds them regularly grazed every winter by stock leaving good pasture to do so. He concludes that pampas has an economic value hitherto undreamed of and a definite place in every farm in the future.

The difficulty of providing winter feed on a bush section where there is no ploughable land may possibly be overcome by the use of pampas.

ABSTRACTS

Sugarcane in the Punjab, Part I. P. E. LANDER and RAMJI NARAIN (*Ind. J. Agric. Sci.* **5**, 213).

The sugar industry of the Punjab must depend for its success very largely on the new imported Coimbatore varieties, the quality of which, taken as a whole, has shown a steady improvement during recent years due to the introduction of continually improved varieties. The sugarcane-survey carried out from 1927 to 1932 in a number of districts of the Punjab has shown that these new varieties invariably give better yields of cane and sucrose per acre than do the local canes. Based on yields per acre the South Eastern Punjab appears better suited climatically for the production of cane than other localities although the Central Punjab produces a somewhat better cane. With the introduction of these new varieties, the period of optimum ripeness during which the cane is available for crushing has been considerably extended and now varies from 120 to 135 days according to locality. Since most Coimbatore varieties do not ripen before December, the cultivation of early ripening local varieties such as Katha, Lalri, etc., is still a necessity for early crushing.

All varieties are susceptible, in varying degree to the ill effects of frost, and the extent of the damage depends very largely on the condition of the cane at the time frost occurs, healthy canes and those which have received recent irrigation or rainfall will be able to resist frost much better than the same varieties deprived of these mitigating circumstances. Generally speaking the Coimbatore varieties may be arranged as follows in order of decreasing resistance to frost :—

Co. 270, Co. 281, Co. 285, Co. 290, Co. 213, Co. 223, and Co. 205.

Canes with succulent leaves and a low fibre content have been found to be particularly susceptible to injury by insects and disease.

The flowering of canes which occurs only in the case of Coimbatore varieties, marks the end of vegetative growth and does not indicate any deterioration in the quality of the cane, and is very likely the result of the particular climatic condition prevalent from September to December.

Ratooning is becoming increasingly popular with the introduction of the new Coimbatore canes, as these have proved to be particularly well suited for this practice. The ratoon canes, however, furnish a continuous source of food supply to the various pests common to the crop, and a close watch on a ratoon crop is therefore necessary if the multiplication and spread of such pests is to be avoided. (*Authors' abstract*).

Organisms associated with sugarcane mosaic and their relation to the mosaic virus. S. V. DESAI. (*Ind. J. Agric. Sci.* **5**, 367).

A method for isolating species of pleomorphic unstable bacteria from sugarcane affected with mosaic has been standardised, and the different cyclostages of these bacteria have been studied morphologically, biochemically and culturally.

The bacteria are unique in having a short bacterial cyclostage and an unusually long filterable and invisible cyclostage.

The relation of this filter passing cyclostage to the mosaic virus has been established by serological reaction ; for this purpose rabits were immunised by inoculating increasing doses of (1) mosaic virus, (2) filterable form of bacteria, (3) bacteria and (4)healthy leaf juice.

The agglutination, precipitation and complement fixation reactions brought out the relation of mosaic virus and filterable forms of the bacteria. In vitro neutralisation and inactivation of the mosaic virus was brought about by the anti-mosaic virus serum and anti-filterable form serum. While anti-healthy juice serum and the anti-bacterial serum failed to inactivate the mosaic virus. Thus a relationship based on neutralization and inactivation of the pathogenic principle was shown to exist between mosaic virus and the filterable forms of the organisms.

Biochemical reactions of the organisms were different from all known species of bacteria. (*Author's abstract.*)

Stinking rot of sugarcane. S. V. DESAI. (*Ind. J. Agric. Sci.* **5**, 387).

A new disease of sugarcane was observed at Mushari Sugarcane Research Station. The symptoms of the disease were wilting of the canes and rotting of the plant from top downwards with a strong smell of fermenting debris. The disease appeared during monsoon, the affected plants rotted very quickly and the stem became a mass of semi-solid stinking pulp. Hence it is named " Stinking rot ". The causative organisms were isolated and studied. Two types of bacteria were found in the affected tissues. One was pathogenic and the other saprophytic but the mixed cultures were found to be much more affective in bringing about the disease by artificial inoculation.

Biochemical and cultural reactions of the pathogenic organisms were allied to organisms of the pyocyaneous group but differed from *B. Xanthochlorum*, *B. aptatum* and *B. marginale*, which represent the allied pathogenic types of this group.

The organisms were non-pathogenic to potato, beans, tomato, tobacco and other plants tried. The pathogenicity being confined to sugarcane. Infection in plants is considered to be through top shoot borer holes. The " dead heart " formed a suitable medium for mass development which initiated vigorous rotting, some plants being killed within a fortnight. (*Author's abstract*).

The parasitism of *Sclerotium oryzae* Catt. B. B. MUNDKUR, (*Ind. J. Agric. Sci.* **5**, 393).

Differences in the symptoms of sclerotial disease of rice as described by different investigators are pointed out. Cultures assembled from various geographic locations fell into four groups and this paper deals with two of them. One *Sclerotium* had coloured hyphae, small smooth sclerotia and ability to change the colour of certain substrates and was identified as *Sclerotium oryzae* Catt. The other had a hyaline mycelium, was unable to change the colour of substrates, possessed larger sclerotia with a rough surface and was identified as *Rhizoctonia microsclerotia* Matz,

Disease was not produced in pots and fields heavily infested with sclerotia. The fungus occurs in the rice fields and sclerotia can be seen infesting the sheaths and culms of healthy plants. Some plants with excessive tiller had sclerotial infestation while a large number did not. Sterility could not be correlated with the presence of these fungi. The conclusion is drawn that under normal Indian conditions, *S. oryzae* is unable to produce any disease in rice. (*Author's abstract.*)

Some observations on the essential oil content of rosha grass (*Cymbopogan Martini* var. *motia*). GIRDHARI LAL (*Ind. J. Agric. Sci.* **5**, 415)

A study of the seasonal variations in the oil content of rosha grass (*Cymbopogan Martini* var. *motia*) shows that the leaves yield the largest amount of oil throughout the season. The whole plant gives the maximum amount of oil about a week after flowering. The time extending from the fourth week of October, and the third week of November has been found to be the 'maturity' period and best suited for harvesting the crop and distillation of oil.

Intermittent attacks of frost decrease the oil content of the leaves, flowers and the entire plant to the extent of 13 per cent, 59 per cent, and 32 per cent. respectively.

Stacking the grass before frost does not arrest the decline in the oil content. The crop, for distillation purposes, should therefore be harvested before the onset of frost.

Chemical examination of the oil indicates that the leaves (96·06 per cent total geraniol) yield the best quality oil; flowers-heads (94·43 per cent total geraniol), and stalks (95·03 per cent total geraniol) give an oil of slightly inferior quality; whereas the stacked grass (91·93 per cent total geraniol) yields the poorest quality of oil. (*Author's abstract*).

Studies on *Rhizobium leguminosarum* of berseem (*Trifolium alexandrinum*) M. R. MADHOK (*Ind. J. Agric. Sci.* **5**, 428).

A study has been made of the organism infecting the roots of berseem or Egyptian clover. The organism has been found to be a pseudomonas having its cross inoculant in the organism infecting the roots of *shaftal* (*Trifolium resupinatum*).

The growth of the organism on some of the more important media has been studied. The pH tolerance of the organism has been found to be as low as 5·0 on the acid side and 10 or probably a little more on the alkaline side. The thermal death point has been found to vary from 52°C. to 54°C. though in fully grown soil cultures it has been able to resist a temperature upto 75°C.

The movement of the organism in soil is very slow hardly half an inch in 15 days.

The organism retains its infective power on the inoculated seed for about seven weeks.

Ultra violet rays exert an injurious effect on cultures of the organism. (*Author's abstract*).

The influence of progressive ripening of fodders on the mineral nutrition of cattle, Part I.—Mineral composition and the mineral balance as influenced by progressive ripening of fodders. A. VISWANATHA IYER (*Ind. J. Vety. Sci. and Anim. Husb.* **5**, 129).

The first paper in this series deals with two distinct questions :—

(*a*) The mineral composition of some fodders.

(*b*) The assimilation of minerals from these fodders.

The mineral composition of four fodders, *viz.*, (1) Rhodes grass hay, (2) Aurangabad hay, (3) Spear grass hay and (4) *Juar* hay at different stages of maturity, has been determined.

The mineral content was found to vary from fodder to fodder and with the state of maturity.

Feeding tests were carried out with these fodders to study the assimilation of minerals.

It was found that the state of maturity greatly affected the mineral assimilation, the first cut invariably gives positive mineral balances and the mineral balance becomes less favourable as maturity advances.

To obtain positive balances, both Ca and P must be sufficient. For example with *Jouar* P intake is always high, yet, owing to low Ca intake, balance of both Ca and P becomes negative.

The actual minimum intake values found in these experiments are.—10 grms. P_2O_5 and 15 grms. CaO for an animal of 750 lbs. live-weight. With less Ca and P than these amounts no positive balance is possible under any circumstances.

Another point of interest is that while a positive lime balance can be obtained when the lime is above the minimum but the phosphoric acid below, the converse, *viz.*, a positive phosphoric acid balance when lime is below the minimum seems unattainable.

It must be emphasised that these mineral quantities yield positive balances when conditions are otherwise favourable. (*Author's abstract*).

The influence of progressive ripening of fodders on the mineral nutrition of cattle, Part II.—Urine characteristics as influenced by progressive ripening of fodders. N. KRISHNA AYYAR (*Ind. J. Vety. Sci. and Anim. Husb.* **5**, 140).

Four typical fodders at different stages of maturity were fed to cattle and the acid base balance of the resulting urine was studied. It has been noted that the early-cut fodders are marked by the elimination of large volumes of urine, definitely attributable to the high amount of alkalis in the food and that with advancing maturity the total fixed bases decrease and the pH of the urine tends to become lower. The bases in the urine of two early-cut fodders were very low and later-cuts of the same fodders showed serious deficiency of bases. One late-cut fodder produced definite nutritional acidosis marked by a large increase of urinary ammonia; the acidosis being due not to increased acid production but to the deficiency of fixed bases. Two

of the fodders were grown on similar soil, yet the one yielded a highly alkaline urine and the other an acid urine. Hence the species of grass and the stage of maturity both profoundly influence the mineral supply to and the acid base balance in the animal.

Lime and magnesia show increased deflection into the acidic urine. The excretion is not proportional to the intake but depends almost entirely on the pH of the urine. This suggests that the animal experiences difficulty in retaining minerals when the urine becomes acid. This view is supported by the mineral balance data presented in the paper. Urinary loss of calcium being closely related to the pH of the urine, it is possible that calcium assimilation is influenced by urine reaction.

It has also been observed that there is an inverse relationship between urinary lime and urinary phosphoric acid. (*Author's abstract*).

The influence of progressive ripening of fodders on the mineral nutrition of cattle, Part III.—The blood characteristics as influenced by progressive ripening of fodders. N. C. DAS GUPTA (*Ind. J. Vety. Sci. and Anim. Husb.* **5**, 148).

A marked change in the inorganic phosphorus of blood of bullocks is noticeable within three days after a change of ration and the full effect of the change is attained in less than three weeks. The level of the inorganic phosphorus of serum is dependant upon both the dietary phosphorus level and the nature of the food.

Blood calcium varies with different fodders. It is not related to the calcium content of the food, and there is no direct relationship between the Ca/P ratio and the serum calcium, but the blood calcium level is influenced by the nature of the food and the stage of maturity of the fodder. Serum calcium is frequently parallel to the acid base balance and the urinary excretion of calcium ; but there are important exceptions to these rules.

During the course of this work certain modifications in the methods of blood analysis were found to be advantageous and are described in the text. (*Author's abstract*).

Minerals in pasture grasses in India. A. VISWANATHA IYER (*Ind. J. Vety. Sci. and Anim. Husb.* **5**, 184).

In this paper the mineral composition of three species of grass, *viz.*, *Andropogon contortus*, *Cynodon Dactylon* and *Pennisetum cenchroides* grown at Pusa, Sabour and Bangalore has been studied.

Description of soil and its influence.—Pusa soil is a light sandy loam with a very high lime and very low available P_2O_5 and K_2O contents.

Sabour soil is a slightly heavier sandy loam with an average mineral content.

Bangalore soil is red laterite with a very low lime content and average P_2O_5 and tending to be acidic.

It was found that distinct differences in mineral content of the grasses could be attributed to the soil. For example, the plants grown at Pusa contained more lime and less phosphoric acid than the average.

Influence of species.—It was found that each species of grass showed a tendency towards a mineral make-up peculiar to itself. *Cynodon Dactylon* invariably showed a considerable excess of lime over phosphoric acid while in *Pennisetum cenchroides* the tendency was for phosphoric acid to exceed the lime. This is rather unusual and is seen only in one other example, *viz.*, *Jouar* reported in "The influence of Progressive Ripening of Fodders on the Mineral Nutrition of Cattle, Part I, 1935".

Influence of maturing.—Maturity was found to exert a considerable influence on the percentage of nitrogen and potash in the grass, and a smaller influence on the percentage of phosphoric acid and only a minor effect on the percentage of lime and magnesia.

Influence of cultivation.—There is an indication that cultivation is likely to affect the mineral content of herbages for example, *Andropogon contortus* grown at Bangalore in 1932. (*Author's abstract*).

Globidiosis in Indian cattle, with a description of a new species. S. R. HASSAN (*Ind. J. Vety. Sci. and Anim. Husb.* **5,** 177).

The article records clinical observations and laboratory findings regarding the protozoon organism *G. fusiformis*, in cattle in India. This organism has not hitherto been reported in this country and it will be of interest to workers engaged in clinical meat-inspection and *post-mortem* examinations.

The observations are based on the study of five cases in the ox, four being in transport bullocks purchased in the United Provinces, and the fifth case was a cow in Gurgaon district of the Punjab.

The infection was associated with rinderpest infection, therefore no definite clinical syndrome could be attributed to this parasite alone, excepting that the bowel disorder in the course of the rinderpest was very much aggravated and the excreta were stained red due to haemorrhage in the alimentary tract.

Post-mortem examination revealed the presence of whitish, spherical, parasitic bodies resembling sarcosporidial cysts in the mucosa of the aboma sum, duodenum and ileum. The general appearance of the affected mucous membrane varied according to the amount of infection. The areas heavily infested were raised from the surface, became thickened and showed petechiæ, ecchymoses and hæmorrhages of varying dimensions.

There were also patches of connective tissue hyperplasia and erosions in the mucosa, which were considered the site of ruptured cysts. The size of the cysts was on an average 1 mm. in diameter.

For diagnosis repeated microscopic examinations of the fæcal stained smears were necessary, as the spores and young cysts were not easily appreciated and studied in unstained fresh preparations. In the writer's hands Giemsa's stain proved to be the best.

Microscopical examination reveals that each cyst is composed of spherical refractile plasmodic globules varying in size from 60 to 90 and having up to 48 or more nuclei in a single optical plane. These nucleated globules develop into spores, which when mature appear as elongated spindle-shaped bodies with both ends tapering, one being more finely pointed than the other, and measuring ·13 mm. in length on the average. The nucleus is vesicular in type, oval in shape, and is located more towards the less pointed end.

The writer is of the opinion that the parasite is causing injurious effects in the alimentary tract of cattle by direct invasion and possibly acting as a medium to expose the tissues to other infections, and must therefore be regarded as a cause of exonomic loss to cattle-owners in this country. (*Author's abstract*).

A hitherto undescribed piroplasm of goats (*Piroplasma taylori* Sp. nov.) S. M. Sarwar (*Ind. J. Vety. Sci. and Anim. Husb.* 5, 171).

A new species of ovine piroplasm has been described and named *Piroplasma taylori* Sp. nov. The parasite was recovered by the author from a goat which had recently died in village Malwale, District Sheikhupura, Punjab. The *post-mortem* findings are recorded and from these it is presumed that the goat died of piroplasmosis.

The author has discussed in detail the morphological and divisional characters of the hitherto known piroplasms of goats and sheep, and compared them with *Piroplasma taylori*. The chief distinctive features of this new species are its morphological and divisional characters. Contrary to the usual mode of division of the known ovine piroplasms, the parasite is found to divide into two elements or into multiples of two, at one and the same time. The number into which the parasite is to divide appears to be predetermined. The parasite occurs in the red blood cells either singly or in 2, 4, 8 and 16 elements. Extra cellular parasites also, in different stages of division, are frequently observed.

The generic name of piroplasma has been retained by the author, for the present, on account of the inadmissibility of the three recognised genera ; *Babesia*, *Nuttallia* and *Theileria*. (*Author's abstract*).

Bovine surra in India, with a description of a recent outbreak. P. R. Krishna Iyer and S. M. Sarwar (*Ind. J. Vety. Sci. and Anim. Husb.* 5, 158).

An outbreak of bovine surra which occurred in the Imperial Cattle Farm at Karnal in which the affected animals exhibited symptoms of brain affection is described. A résumé of previous outbreaks of this condition in India with special reference to the symptoms noted in each outbreak is given. "Bayer 205" was found to be an efficient therapeutic and prophylactic agent in the control of this disease. Tartar emetic was not found to be suitable for this purpose on account of its toxicity and failure to prevent relapses in the treated animals. (*Author's abstract*).

P.

Studies on the problem of variation and heredity of the milk yield in dairy cattle. LIBIZOV, M. P. (*Proc. Leningr. Inst. Dairy Cattle Breed*, **1**, **34-55**, **1933**.)*

In analysing 1203 lactation yields for the years 1907-1931 of Red Danish cattle at the dairy farm of the Institute, the author comes to the conclusion that feeding must be regarded as the major cause of variability of the lactation yield. The history of the herd may be divided into five periods, during which the average yield varied, as follows: I. 1907-1913, good feeding, yield $=336\pm39\cdot6$ kg. II. 1914-17, poor feeding, yield $=2065\pm25$ kg. III. 1918-1924, very poor feeding, yield $=2258\pm53$ kg. IV. 1925-1930, good feeding, yield $=3658\pm53$ kg. V. 1931, somewhat poorer feeding, yield $=3294\pm81$ kg. The author thinks that the rise from period I to period IV may be ascribed to the improvement of the herd by selection. Correction figures for the differences in feeding have been calculated, bringing the periods II and III to the level of period I and period V to that of period IV. They are as follows: for period I=0, II=1·141, III=1·485, IV=0, V=1·111. A second factor of the major importance is age, and the author gives the following correction figures ; for 1st lactation, 1·377 ; 2nd, 1·200 ; 3rd, 1·068 ; 4th, 1·031 ; 5th, 1·014 ; 6th, 1·000 ; 7th, 1·014 ; 8th, 1·046 ; 9th, 1·078. The author thinks that only corrections for the first three lactations are of practical importance, but, as he points out, these corrections are right only on the average, and the individual rate of development may show considerable variations. An attempt is made to show that these variations may be of hereditary nature. On a material of 9 daughters of a sire, Bobr No. 664, it is seen that these daughters show on the average a much earlier development than the herd. If the heifer yield is taken as 100, then we get the following values :—

Daughters of Bobr No. 664 . . .	100	133·6	153·4	155·6	148·4	149·9
Herd average . .	100	114·7	129·0	133·5	135·7	137·7

The author thinks that a selection for early age at maximum yield must be of practical importance (D. Kislovskii).

* Reprinted from the *Animal Breeding Abstracts*, Vol. II, No. 2, July 1934.

NOTES

SYNOPSIS OF THE PROCEEDINGS OF THE AGRICULTURAL SECTION OF THE INDIAN SCIENCE CONGRESS, 1935

The Agricultural Section was well attended by scientists from all over India and had a fruitful session. Dr. Shaw in his presidential address dealt with the improvements in Indian crops effected by plant-breeding. He showed how improvements in quantity, quality and disease-resistance were the aim of plant-breeding work. The study of the inheritance of the property of resistant to wilt in *rahar* was a typical example and had yielded types which were resistant to the disease caused by Fusarium. This resistance could be combined with any desirable morphological character. Referring to the classic researches on wheat-breeding which had produced heavy yielding and good quality wheats, he stressed the necessity of furthering the work for producing rust-resistant varieties. The breeding of high-yielding varieties of linseed and other oil-seeds had assumed an enhanced importance due to the impetus received from the Ottawa Trade Agreement, but much remained to be done to evolve improved high-yielding varieties suitable for the Gangetic alluvium.

The discovery of new potato types in South America had offered an unique opportunity of studying the complicated problems of potato culture and foreshadows the possibility of brilliant results. The improvement and popularity of the Coimbatore sugarcanes bear an ample testimony to the success which may be obtained by sustained breeding work. The ever-increasing demand for, and the spread of, new varieties of high-yielding and disease-resistant sugarcane is a matter of common knowledge, and the successful production of inter-generic hybrids between sugarcane and sorghum may, by shortening the growing and ripening periods, revolutionize the whole cane-sugar industry. The importance of cytological investigations running side by side with breeding work must be recognised and much could be done by university laboratories undertaking the study of these problems in conjunction with the genetical research. Improved methods of cultivation must accompany the introduction of improved varieties if the full benefit of research is to be obtained, and in this respect much remains to be done.

The Session opened with papers on Agricultural Statistics. Mr. Vaidyanathan gave at length his deductions from the Cawnpore permanent manurial experiments, about the order of efficiency due to different treatments during successive quinquennia and explained the causes of variation by postulating

deterioration, slow changes and annual variation. Each factor was statistically evaluated. He concluded that for wheat and maize an annual application of 100 lbs. of nitrogen per acre was inferior to 50 lbs. of nitrogen both in direct and residual effects. Dr. Kalamkar read a paper on the same subject and complimented Mr. Vaidyanathan on improving and extending the data worked out by him. Various anomalies due to insufficient replications, paucity of corrective formulæ were discussed. Prof. P. C. Mahalanobis described a complex lay-out for cultural experiments with rice, where in one experiment the effect of various factors such as five dates of planting, three distances of spacing, three different numbers of seedlings per hole on early, medium, and late varieties of rice were evaluated singly and in combination. The lay-out of such experiments presented many practical difficulties but minimised the space required and indicated the best combination of factors.

Dr. Ram Das and his co-workers at Poona opened the discussion on the papers on Agricultural Meteorology. Though this branch of science is a new development in India some interesting observations were put forward. One which caught the imagination of practical agriculturists was the foretelling of frosts and methods of combating this calamity. The putting up of wind screens, small heating devices, and irrigation at the critical periods, were considered and debated. The greatest damage was found to occur some two inches above the ground level and this was meteorologically and experimentally proved to be due to the temperature at that level being the lowest.

Discussions on agricultural chemistry and microbiology were opened by Mr. Wad of Indore in connection with irrigated cotton experiments in the newly-inaugurated Gang canal area ; the data were discussed and the conclusion put forward that adjustment of the water balance in the soil to the physiological requirements of the crop alone would lead to really efficient crop improvement.

Mr. Joshi then explained his work on the bacterial flora of silages of different materials and showed how a mixture of two fodder plants like berseem and *Dhub* grass which by themselves yield a very poor silage formed a rich and nutrient silage. Addition of molasses to wheat and oat straw improved the product after ensiling and these improvements were traced to the favourable conditions produced for the growth of *Streptococcus lactis* which produced a desirable fermentation, thus showing a way to prepare a good silage from materials which are not usually utilized for the purpose. In discussion the suggestion was put forward that it was a matter of hydrogen-ion concentration and that similar improvements could be effected by adjusting the pH of the material intended for the silage. Mr. Das explained the efficiency of apricot seed cake as a nitrogenous manure and advocated the use of this cake as a manure instead of allowing it to be burnt as fuel as it is at present done in the Simla hills. The efficiency of this manure was proved in almost all types of soils deficient in nitrogen and a good residual effect persisted in the manured soils. Mr. Batham opened a discussion on the

manuring of sugarcane and the relationship of organic and inorganic nitrogen to the ripening of the canes. He concluded that the poorer the soil was in organic matter, nitrogen and moisture, the earlier the cane crop would ripen and the less would be its tonnage ; with an increase of organic matter and nitrogen in the soil the maturation period was prolonged but an increase in tonnage took place at maturity. Mr. Khanna, laying stress on the waste of manure taking place by the uniform manuring of all varieties of sugarcane at the time of planting and earthing-up, advocated the application of manure according to the times of root flushings, which varied in different varieties. Manuring on the appearance of the white new roots of the stools, which could very well be ascertained by removal of the surface soil from a few clumps, was found experimentally to result in better growth and greater yields at the harvest. Mr. Sanyal explained his experiments on the efficacy of different manures for sugarcane and showed that superphosphate and mustard cake is the most efficient combination economically in a calcareous soil. The increased yields obtained thereby were statistically significant.

Mr. Alam explained his physiological studies on the salt tolerance by paddy and showed how initial treatment with weak saline solution developed progeny which could tolerate saline conditions of the soil. The percentage germination of the seeds soaked in saline increased over that of the control.

Mr. Bose showed how some hereditary anatomical characters were found to be responsible for lodging in barley. The development of the mechanical tissues which gave strength to the stand was controlled by Mandelian factors. Width and thickness of sclerenchyma, length and diameter of the vascular bundles, determined the lodging or non-lodging characteristics. Rao Bahadur Rangaswami Ayyangar showed that spikelet-bearing bristles in *Pennisetum typhoides* were occasionally met with. The bristles sometimes bore sterile flowers, showing that the bristle was a modified peduncle.

Dr. Likhite described his observations on the root-rot of cotton in Gujarat. Four organisms were constantly found in the affected roots, and of these *Rhizoctonia* yielded some evidence in favour of parasitism. Dr. Mitra explained varietal resistance in barley to *Helminthosporium*. Environment played a great part in bringing about the disease. Early varieties seemed to suffer less. None of the controlling treatments were found effective in completely controlling the disease. Selection of resistant types showing the desired agronomic characters was the only remedy. Dr. Mundkur described discrepancies in the descriptions of the symptoms of the Sclerotial disease of rice by different investigators. The sterility engendered in the diseased plants could not be correlated with the presence of the fungus, and the conclusion was drawn that under Indian conditions *S. oryzae* was not the cause of the disease in rice.

Dr. Desai described a new disease of sugarcane which occurred in the sugarcane damaged by borer during monsoon. The parasite was found to be a bacterium of the Pyocyaneus group which showed pathogenicity for sugarcane alone. He

then compared the antigenic properties of the mosaic virus of sugarcane with those of the juice of healthy sugarcane. *In vitro* neutralization of the infection principle was brought about by the anti-virus serum while anti-healthy juice serum was unable to effect similar neutralization. Some of the physical properties of the sugarcane mosaic virus were explained and the action of different chemicals on the virulence of the virus showed that sugarcane mosaic virus was very highly sensitive and the least resistant as compared to other plant viruses.

Mr. Mukherji gave a life-history of a *Trichogramma* parasitic on the eggs of bruchid beetles, and suggested its trial in the control of bruchid beetles.

Mr. A. V. Iyer gave data of the mineral composition of pasture grasses grown at widely different centres. The effect of various minerals in the soil on the mineral contents of the grasses was brought out. Selective absorption varied in different grasses. Assimilation of minerals by farm animals was the next subject discussed. It was found that when the intake of phosphorus (P_2O_5) and calcium (CaO) fell below 10 grams and 15 grams, respectively, there was no positive balance possible even if all other conditions were favourable. Under unfavourable conditions a negative balance resulted even in cases where the intake was twice or thrice the minimum quantity. It appeared that the most favourable condition for avoiding loss of calcium and phosphorus was that the resultant urine should be quite alkaline. As alkalinity decreased, the retention of phosphorus and calcium tended to decrease, in cases where the urine was acid there was definite loss of phosphorus and lime.

Dr. Nehru advocated the use of the electric motor in ploughing very bad and hard fields and claimed that the difficulties met with in other methods could be overcome by electric ploughing. He also explained the application of electro-cultural methods to fruit farming and stated that a definite and satisfactory response was obtained in most of the cases tried.

CONTINUATION OF THE COTTON ACREAGE REDUCTION SCHEME IN THE U. S. A.

Introduction

The U. S. A. Proclamation regarding the continuation in 1935 of the cotton acreage reduction scheme, together with the official explanatory press communique, is reproduced below, being of general interest to cotton growers in India. It will be observed that under the new plan contracting farmers will have to reduce their cotton acreage by not less than 25 per cent and not more than 30 per cent on their average acreage for 1928—32, as compared to a reduction of 40 per cent in 1934. The rental payments for land held vacant under this scheme will

be at the rate of 3½ cents per lb. of cotton on the average yield per acre during basic period but subject to a maximum of 18 dollars per acre. The necessary finance will be provided by a continuation of the process tax of 4·2 cents per lb. on cotton consumed in the U. S. A. It was estimated that disbursements in 1935 will be 94 million dollars.

INFORMATION FOR THE PRESS

1935 COTTON ADJUSTMENT PROGRAM IS ANNOUNCED

A reduction of 25 per cent from the base acreage of co-operating cotton producers for 1935, as compared with a 40 per cent reduction in 1934, was officially announced to-day by Secretary of Agriculture, Henry A. Wallace, and Chester C. Davis, Administrator of the Agricultural Adjustment Act.

Acting under the terms of the 1934 and 1935 Cotton Acreage Reduction Contract which provides that the maximum rate of reduction that can be required in 1935 is "to reduce the acreage planted to cotton on this farm by an amount not to exceed 25 per cent below the base acreage". Secretary Wallace today signed a proclamation making effective for 1935 the approximately 1,0(4.(00 two-year contracts signed during the early part of 1934. It also was announced that new one-year contracts for 1935 will be offered to those producers who did not sign the two-year contract. It is expected that new contracts will be available soon so that they may be signed and accepted by March 1, 1935.

The basis of payment for the 1935 program, which, under the terms of the contract must be "similar" to those described in the contract for 1934, is "3½ cents per pound" on the average yield of lint cotton per acre for this farm for the years 1928—1932 with a maximum rental of "$18·00 per acre" for the acres rented under the contract, and a "parity payment" of 1¼ cents per pound on the farm allotment.

The farm allotment, which is the equivalent of 40 per cent of the farmers' average production for the base period of the farm represents that percentage of production which ordinarily moves into domestic consumption.

For the current crop year, 1934, the basis of payment was 3½ cents per pound as rental and a parity payment of 1 cent per pound.

The program as approved by Secretary Wallace and Administrator Davis followed the recommendation of the Cotton Production Section of the Agricultural Adjustment Administration of which C. A. Cobb is chief. In recommending this program, Mr. Cobb emphasised that the rate of production would permit an expansion of about 25 per cent of the acreage planted by contracting producers over the acreage planted in 1934.

"Any rate of reduction less than 25 per cent would not be to the best interest of cotton producers," the recommendations of the Cotton Production Section

stated. "A reduction of 25 per cent offers the possibility of maintaining world supplies of American cotton near present levels and the further possibility of returning to cotton-producers the highest net income consistent with contract provisions and the outlook for American cotton."

The total amount of rental and benefit payments which will be disbursed under the program is estimated at $94,230,000. The program will be financed by the processing tax of 4·2 cents per pound on raw cotton.

Important points in the 1935 cotton program include the following:

(1) Producers who desire to do so will be permitted to reduce up to and including 30 per cent and receive payment therefor. The permitted reduction of an additional 5 per cent is justified to permit more latitude in the arrangement of farm plans of individual producers.

(2) The base acreage of producers who are now signatory to contracts is approximately 38,210,000 acres. It is estimated that producers who did not sign contracts planted in 1934 a total of 6 million acres. If under the offer of new contracts, the base acreage is increased by one million acres, a reduction of the base acreage of approximately 39,210,000 acres by 25 per cent would result in a total of 29,400,000 acres being planted by contract signers. If a total of 5 million acres is planted by non-contract signers, the total planted cotton acreage in 1935 would be approximately 34,400,000. The planted acreage in 1934 was 28 million acres.

(3) With average abandonment of 2·4 per cent, a total of 33,500,000 acres would be left for harvest in 1935. With yields at the 10-year average of 170 pounds per acre on the acreage harvested, the result would be a 12 million bale crop in 1935. (Production for 1934 was estimated on November 1 to be 9,637,000). With a reduced acreage, a somewhat higher yield per acre might result because of a tendency for more intensive cultivation, and other factors. Therefore, on the basis of average weather conditions, it would not be unreasonable to expect a crop somewhat above 12 million bales with the 25 per cent reduction in 1935.

(4) It is estimated that with a 25 per cent reduction but without the Bankhead Cotton Control Act in effect for 1935, total production would be greater and probably would result in a crop of slightly above 13 million bales. Among the factors which would tend to increase total production if the Bankhead Act were not in effect for 1935, would be the development of new cotton lands and the probability of a smaller per cent of non-signers entering into contracts for the 1935 season. It was pointed out by the Cotton Production Section that probable production without the Bankhead Act is a matter of opinion and not subject to precise economic analysis.

(5) The average farm price for cotton for the year ending July 31, 1934 was 9·7 cents per pound. The parity price of cotton is at present 15·6 cents per pound.

(6) World supplies of American cotton are now indicated at 20,200,000 bales for the 1934-35 crop year. This figure is in line with past averages of world supplies of American cotton. With foreign and domestic consumption of American cotton during the current year assumed at 11 to 12 million bales, the indicated carry-over on August 1, 1935, would be between 8 and 9 million bales, which is higher than a normal carry-over. A total production of about 12 million bales in 1935 would result in a world supply of American cotton for the 1935-36 season of about 20 to 21 million bales, which might result in some increase over current supplies in spite of the maximum adjustment under the terms of the contract.

Secretary Wallace, in approving a program which entails the maximum adjustment possible under the terms of the contract, made the following statement :

"In considering the 1935 cotton program, various suggestions have been thoroughly canvassed. These suggestions range from the relaxation of all adjustment of production to an even greater reduction than is possible under the present contracts. The course that has been adopted affords the greatest possibilities from the standpoint of the producer's interest. It should result in a continued ample supply of American cotton that can be purchased by foreign and domestic consumers at prices which, judged by past standards, are not unreasonable. At the same time, this program seeks to avoid the danger of piling up new and disastrous surpluses. It is the nearest approach to a balance that can, under our present knowledge of existing circumstances, be devised. And under the Agricultural Adjustment Act we have a clear mandate from Congress to *maintain* such balance between production and consumption.

"The characteristic argument of those advocating unrestricted production is that such a course would restore our foreign markets. These persons believe that foreign buyers would take increasing quantities of American cloth at *some* price. They have apparently not considered the fact that a situation could easily develop which might result in producing a surplus amount of American cotton that could not be *sold* abroad at *any* price. In 1931 and 1932, United States maintained a relatively high volume of exports but prices to farmers were around 5 and 6 cents during those two years. I do not believe that unlimited production which, with other factors, forced prices down but maintained a high volume of exports proved to be any great benefit to the cotton farmer.

"I do not believe that the answer to the present grave cotton problem is to be found in abruptly returning to the policy of unrestricted production. The program for 1935, although providing for a reduction from the production to be expected in the absence of such a program, affords an expansion in acreage for that season as compared with 1934. If the response to this program is what we expect, and production factors next season are average, there will be some three million bales more cotton added to present supplies. This will maintain ample supplies of American cotton which, I hope, can be sold at a fair price. I could not

subscribe to any attempted solution of the cotton problem which would force the farmers' price down to inordinately low levels in the hope that consumption will increase and the export movement revive. It does not necessarily follow that a reduction in price brought about by increased production would restore the former volume of cotton exports. There are other factors, such as the increasing nationalistic trend of some of our foreign cotton customers, the decline in imports received in this country and the continued low level of foreign purchasing power that are more responsible for recent decline in export movement than the price or production policies in America. Increased production and a lower price might stimulate the value of exports to some degree, but it is not altogether certain that such an increase in volume of exports would increase the volume of dollar exchange available to pay for cotton. It might simply mean that foreign cotton consumers would buy more cotton for the same amount of dollars.

"It also is apparent that there exist at present definite limitations to a continued expansion of cotton acreage in foreign countries under present and probable levels. The additional areas available for cotton production throughout the world are rather limited. After a careful survey of worldwide prospects, the Bureau of Agricultural Economics, in the recent outlook Report, comes to the conclusion that further expansion of cotton acreage in the immediate future outside of the United States is not likely to be a very serious factor in the world cotton situation and that most of the increase that occurred this year represents a restoration of previous reductions rather than new acreage brought in. So the conclusion would not seem warranted that under existing circumstances foreign cotton producing countries will increase their acreage and production *because* of the efforts of the United States producers to prevent the accumulation of new surpluses by holding supplies in line with apparent market possibilities.

"Therefore we have developed a program for 1935 that seems to offer the best opportunity for the cotton farmer to receive the greatest return for his labour and investment and which, we hope, will prevent a recurrence of the disastrous days of 1931 and 1932."

Proclamation continuing in effect for 1935. The 1934 and 1935 Cotton Acreage Reduction Contracts.

Whereas the 1934 and 1935 Cotton Acreage Reduction Contracts provide that the contracts shall apply only for 1934 unless the Secretary of Agriculture shall, not later than December 1, 1934, proclaim his purpose of continuing the Cotton Acreage Reduction Plan for 1935, and said contracts further provide that such proclamation shall state the percentage of reduction which will be required under such contracts for 1935 and that the Secretary of Agriculture shall not be required to give any notice to the producer other than a public proclamation which shall be given to the general press and copies thereof mailed to each County Committee.

Now, therefore, by virtue of the authority vested in the Secretary of Agriculture by the Agricultural Adjustment Act, approved May 12, 1933, as amended, and under the terms of the 1934 and 1935 Cotton Acreage Reduction Contracts, I do hereby prescribe and proclaim and give public notice by this proclamation (copies of which are being given to the general press and mailed to each County Committee) that—

(1) It is the purpose of the Secretary of Agriculture to continue the Cotton Acreage Reduction Plan for 1935;

(2) Each of the 1934 and 1935 Cotton Acreage Reduction Contracts in effect for 1934 is hereby continued in effect for 1935;

(3) The producer under each 1934 and 1935 Cotton Acreage Reduction Contract shall reduce the acreage planted to cotton for harvest during the year 1935 on the farm covered by such contract twentyfive per cent (25%) below the base acreage of such farm as defined under such contract;

(4) The Secretary of Agriculture will accept the rental of additional acres not to exceed five per cent (5%) of such base acreage and make rental payments for the rented acres not to exceed thirty per cent (30%) of such base acreage on the basis set forth in para. 5 of this proclamation;

(5) Rental payments on each of the acres rented under such contract to the Secretary of Agriculture for 1935 of three and one-half cents. (3½) per pound on the average yield of lint cotton per acre for the particular farm in the years 1928—32, inclusive, with a maximum rental of 18 dollars ($18.00) per acre, shall under the terms of the contract be made to the producer in two equal instalments, the first of which shall be made between March 1 and April 30, 1935, approximately, and the second of which shall be made between August 1 and September 30, 1935, approximately; and

(6) Parity payment upon the farm allotment of not less than one and one-quarter cents (1¼ cents) per pound shall under the terms of such contract be made to the producer (for distribution pursuant to the provisions of such contract) between December 1, 1935, and January 1, 1935, approximately.

In Testimony whereof I have hereunto set my hand and caused the official seal of the Department of Agriculture to be affixed at the City of Washington this 28th day of November, 1934.

HENRY A. WALLACE,
Secretary of Agriculture,

BANKHEAD QUOTA FOR 1935.

Secretary of Agriculture Henry A. Wallace has announced that the national quota under the Bankhead Cotton Act would be 10,500,000 bales of 500 pounds of lint cotton for the 1935 season.

Tax exemption certificates for that quantity of cotton will be issued upon application of cotton producers as provided in the Act. In addition to the tax exemption certificates for 10,500,000 bales of 500 pounds that will be issued for 1935, there are certificates for approximately 700,000 bales of 478 pounds of lint cotton issued in 1934 now in the hands of producers. It is improbable that all of the certificates carried over from the 1934 season will be used in 1935.

The formal proclamation continuing the Bankhead Act into the 1935 season and the findings of the Secretary of Agriculture that two-thirds of the producers favour the tax will be submitted within a few days.

The announcement by Secretary Wallace that his investigation indicated that the quantity of cotton that should be allotted was 10,500,000, 500 pound bales was made in order that cotton producers would have the opportunity to make their plans for the 1935 crop.

Secretary Wallace further announced that it would be the purpose to permit producers participating in the Agricultural Adjustment Administration program under voluntary agreements to rent to the Secretary of Agriculture up to and including 35 per cent of their base acreage and receive payment therefor. In the event that co-operating producers take advantage of this privilege and a majority of those not now under contract sign a contract for 1935 which will be offered, approximately $130,000,000 in rental and benefit payments will be disbursed in the program.

It was further announced that individual allotments under the Bankhead Act will be, as nearly as possible, for each co-operating producer that quantity of cotton equal to 65 per cent of his base acreage times the average yield of the farm for the base period.

In accordance with the terms of the Bankhead Act, some exemption certificates will be available for producers on farms not previously engaged in cotton production.

THE PERMANENT COMMITTEE OF THE INTERNATIONAL INSTITUTE OF AGRICULTURE

The Permanent Committee of the International Institute of Agriculture, assembled for the first time under the Presidency of Professor Baron Giacomo Acerbo, has now terminated its March meeting after holding six sessions. After

the discussion of certain questions of finance and internal administration, the Committee proceeded to consider the question of the special studies to be undertaken by the Bureaux in carrying out the resolutions adopted by the General Assembly at its reunion in October last, and adopted the recommendations of the Secretary General that special attention should be paid to cotton and to the international market for meat of all kinds.

In addition the Committee unanimously accepted the recommendations of a special Commission, appointed to give effect to a resolution of the recent Assembly, arising out of a report presented by Mr. F. L. McDougall, Delegate of Australia, and referring to the scientific work of the Institute. This Commission consisted of Sir John Russell, Director of the Rothamsted Experimental Station (England), Senator Strampolli, the Italian wheat geneticist, and Professor Jonescu Sisesti, Director of the Agricultural Experiment Station of Bucarest, together with certain members of the Permanent Committee and of the staff of the Institute. The report recommended that the Institute should concentrate its scientific work rather upon the practical and international side of the results of scientific developments than upon recording the progress of the more purely scientific aspects.

The Committee next approved the method proposed for the regular publication in convenient form of the collected measures notified by the governments of the various countries, relating to prices, tariffs, premiums on exports and monopolies in so far as they relate to agriculture.

In dealing with the preparations now in course for collaboration between the Institute and the other great International Organizations, the Committee, *inter alia*, approved the agenda proposed for the meeting of the Joint Agricultural Advisory Committee (the liaison organ between the Rome Institute and the International Labour Office), to be held in Geneva on 28th May, and established the general lines of the co-operation of the Institute with the Economic Committee of the League of Nations in the matter of the sanitary inspection of the imports, exports of plants and of other vegetable products, a question referred by the Monetary and Economic Conference of London to the International Institute of Agriculture and to the Economic Committee of the League of Nations.

The Committee in addition signified its approval of the provisions made for collaboration between the International Institute of Agriculture and the International Federation of Olive Growers recently established in Rome. Definite instructions were also given regarding the future conduct of the Institute's statistical work, founded on the data supplied by Farm Accountancy offices.

It was further arranged that the date of 4 June 1935 should be fixed for the meeting in Rome of the International Diplomatic Conference for the standardization of the methods adopted for the analysis of wines intended for international trade, while the date of 15 October 1935 was arranged for the other proposed

International Diplomatic Conference on the question of the standardization of the systems for the keeping and uses of cattle herd books. Lastly the Committee nominated its own representatives at the various conferences, etc., for the consideration of questions relating to agriculture, which will be held during the current year.

ROUND-TABLE DISCUSSION ON NUTRITIONAL PROBLEMS AT THE NEXT CONGRESS OF THE FAR EASTERN ASSOCIATION OF TROPICAL MEDICINE

The following circular letter has been received from the Local Secretary of the Far Eastern Association of Tropical Medicine :—

During the second Council Meeting of the ninth Congress of Far Eastern Association of Tropical Medicine at Nanking, Dr. de Langent (Batavia) proposed, seconded by Dr. Kune and endorsed by Colonel Russel, that the question of nutrition in its widest sense, being of such very great importance in the Far East, should be specially brought before the next Congress, as a main subject. Dr. de Langen had had no time to discuss the matter beforehand with Dr. Rosedale, but would do so on his return to Netherlands India, and proposed that two or three rapporteurs should assemble material dealing with this matter and send it in before the next Congress.

This proposal was agreed to unanimously.

Consequently, the following resolution was passed : That in view of the importance of the food-factor in diseases, a section on Food Problems be added to the programme of the next Congress.

The outcome of the discussion between Dr. de Langen and Dr. Rosedale has been the composition of a circular letter, a copy of which you will find enclosed herewith.

In order to obtain good co-operation I wish to suggest that you have the circular letter published in the local medical periodicals of your country.

All correspondence on this subject, as far as concerns the next Congress of the Featm, should be addressed to the Director of Public Health, Parapattan 10, Batavia—C, Java, Netherlands India.

At the next Congress of the Far Eastern Association of Tropical Medicine, it is proposed to hold a round-table discussion on nutrition, and we have been asked by the Council to make preparation for it.

Papers are invited upon nutrition from the widest point of view and we should be glad if you will be so good as to ask trained observers who are working on any aspect of the subject in your country, whether they will kindly contribute to the discussion by reading a paper on their work under any of the sub-headings below :

If suitable support is forthcoming, it may be possible to combine the papers received and the discussions in a volume, which would constitute an up-to-date account of nutrition as concerns the East.

It is hoped that some indication of the support which may be expected from your country may be received during 1935 though it will not be necessary for titles of papers to be sent in until a later date which will be notified in due course. Such co-operation will enable the Council to know how much time should be allotted for the discussion.

It has been proposed to divide papers under three headings as follows :—

I. *Economics.*—To include such aspects as agriculture in relation to human nutrition, *e.g.*, improvement of yield and quality of food crops ; horticulture ; fruit growing ; stock raising ; dairy problems ; institutional feeding ; food surveys ; storage ; cooking, etc., etc.

II. *Chemical and Physiological.*—To include food analyses in the widest sense ; vitamin, mineral, fat, protein studies &c.; metabolism, basal metabolism, energy requirements, specific dynamic action.

III. *Clinical.*—Studies of disease in relation to food and diet, the feeding of infants during the first year with special reference to development (height and weight) ; children's diseases in relation to food ; nutritional oedema, atypical beriberi ; the course of infectious diseases under the influence of food ; liver cirrhosis ; anaemias ; skin diseases in relation to food and vitamins ; ulcers of the leg ; leprosy in relation to food ; constitutional diseases, diabetes, obesity, gallstones, gastric ulcer, etc.; clinical value of certain foods, etc.

It should be understood that the above provisional programme is intended to be as wide as possible, and that additional suggestions from those able to make them will be welcomed. It is hoped that the subject of nutrition will receive emphasis from the general and normal point of view as well as from the point of view of disease.

IMPORTS OF PLANTS INTO GERMANY.

The following translation of a Decree dated the 23rd November 1934, issued by the German Government, regarding the Customs Offices entrusted with the clearing of fruit and live plants and fresh parts of plants which are subject to examination on import, is published for general information :—

The following is hereby decreed in virtue of 82 of the Decree for the prevention of the introduction of the San Jose Shield Louse and of Apple Blight, of the

3rd November, 1931 (Reichsgesetzblatt I, page 67) in the wording of the Second Decree of the 8th July, 1932 (Reichsgesetzblatt I, page 351) and of the Third Decree of the 20th April, 1933 (Reichsgesetzblatt I, page 230), as well as in virtue of Articles 1, 2 of the Fourth Decree of the 11th July, 1933 (Reichsgesetzblatt I, page 468) in the wording of the Fifth Decree of the 1st March, 1934 :—

I

Fresh fruit and waste of fresh fruit from America, Australia including Tasmania and New Zealand, China, Hawaii, Japan, Jugoslavia, Mesopotamia, Austria, Portugal, Romania, Union of South Africa, Hungary and British India, further fresh fruit and waste of fresh fruit, as well as live plants and fresh parts of plants, from Bulgaria, Greece, Poland, Spain and Czecho-Slovakia may, in as far as their import is not prohibited, until further notice only be imported *via* the following customs offices :—

(a) *Prussia*

Chief Customs Offices —

Stattin Auslandsverkehr, Konigsberg/Pr. ; Hollanderbaum ; Elbing.

Customs Offices at :—

Aachen Bahnhof West ; Bentheim ; Beuthen ; O. S. Bahnhof ; Borken, Cranenburg ; Deutsch-Eylau Bahnhof ; Emmerich Bahnhof ; Eydtkuhnen Bahnhof ; Firchau Bahnhof ; Eraustadt Bahnhof ; Gronau Bahnhof ; Kreuz Bahnhof ; Leibau Bahnhof ; Lublinitz Bahnhof ; Mittelwalde Bahnhof ; Neu Bentschen ; Neumittelwalde Bahnhof ; Oderberg Bahnhof ; Schwanenhaus ; Soidenberg Bahnhof ; Stettin Freibezirk ; Straelen ; Tilsit Bahnhof ; Tilsit Memelbrucke ; Trachenberg Bahnhof ; Ziegenhals Bahnhof ; Prostken Bahnhof.

Customs Branch Offices :—

Berlin—Tempelhof Flughafen ; Breslau Grossmarkthalle ; Emmerich am Rheinufer ; Eydtkuhnen Land ; Kaldenkirchen Bahnhof ; Kiel Nordhafen.

(b) *Bavaria*

Chief Customs Offices :—

Fuhrt im Wald ; Lindau ; Simbach.

Customs Offices :—

Asch Bahnhof ; Eger Bahnhof ; Eisenstein Bahnhof ; Kufstein ; Lindau-Rentin ; Munchen Grossmarkthalle ; Passau Bahnhof ; Salzburg ; Worth (Pfalz).

(c) *Saxony*

Customs Offices :—

Bad Schandau fur den Schiffsverkehr ; Bodenbach, Reitzenhain, Tetschen ; Voitersreuth ; Warnsdorf ; Weipert ; Zittau Bahnhof, vor Zittau.

(d) *Wuerttemberg*

Chief Customs Office :—

Friedrichshafen.

Customs Office :—

Friedrichshafen Guterbahnhof.

(e) *Baden*

Chief Customs Office : —

Kehl.

Customs Offices :—

Breisach, Singen Bahnhof ; Winterdorf.

Customs Branch Offices :—

Basel Eilguterbahnhof ; Basel Verschubbahnhof.

(f) *Mecklenburg*

Customs Office :—

Warnemunde.

(g) *Hamburg*

All Customs Offices at Hamburg and the Customs Office at Cuxhaven.

(h) *Bremen*

Customs Offices :—

Bremen Bahnhof ; Bremen Zollauschluss I ; Bremen, Zollausschluss II ; Bremerhaven.

(i) *Luebeck*

Chief Customs Office :—

Luebeck.

II

The provision under I applies also to the import of live plants and fresh parts of plants from America, Australia including Tasmania and New Zealand,

China, Hawaii, Japan, Jugoslavia, Mesopotamia, Austria, Portugal, Roumania, Union of South Africa, Hungary and British India, in as far as the import is exceptionally permitted.

III

The Decree enters into force on the 10th December, 1934.

The Decrees concerning Customs Offices entrusted with the Clearance of Fruit which is subject to Examination upon import of

the 7th November, 1931 (Reichsministerialblatt page 802)

the 14th May, 1932 (Reichsministerialbatt page 256)

and the decrees concerning Customs Offices entrusted with the Clearance of Fruit and Live Plants and Fresh Parts of Plants which are subject to Examination upon Import of the 15th March 1934.

The 5th June, 1934—

(Reichministerialblatt page 130).

(Reichministerialblatt page 436).

(Reichministerialblatt page 484).

The 17th July, 1934—

(Reichministerialblatt page 130).

(Reichministerialblatt page 436).

(Reichministerialblatt page 484).

are cancelled with effect as from the 10th December, 1934.

Berlin, 23rd November, 1934.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

Under Rule 1 (13) of the Rules and Regulations of the Imperial Council of Agricultural Research the following gentlemen have been elected by the Legislative Assembly as its representatives on the Imperial Council of Agricultural Research :—

1. Maulvi Mohammad Shafi Daudi, M.L.A.
2. Pandit Sri Krishna Dutta Paliwal, M.L.A.

In pursuance of clause (xi) of Section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council has been pleased to appoint Dr. V. K. BADAMI, Economic Botanist, Mysore State, to be a member of the Indian Central Cotton Committee constituted under the said Act, *vice* Mr. A. K. YEGNA NARAYANA IYER, resigned.

In pursuance of clause (xi) of Section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council has been pleased to re-appoint the following gentlemen as additional members of the Indian Central Cotton Committee, constituted under the said Act :—

1. Khan Saheb FARRUKHBEG SADIKALIBEG MIRZA, Bar-at-Law, to represent the Cotton Growers of Sind.
2. Lala SHRI RAM, Delhi Cloth and General Mills, to represent the Cotton Mill Owners of Delhi.

In consequence of vacancies caused by the retirement of nominated members from the 1st April 1935, the following have been nominated to be members of the Indian Central Cotton Committee :—

By the Tuticorin Chamber of Commerce, MR. J. VONESCH.

By the Bombay Chamber of Commerce, MR. M DURUTTI.

By the Upper India Chamber of Commerce, MR. J. TINKER.

By the Durbar of the Baroda State, MR. C. V. SANE.

In pursuance of clause (xi) of Section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council has been pleased to appoint MR. K. I. THADANI, Botanist, Sakrand Station, Bombay Presidency, to be a member of the Indian Central Cotton Committee constituted under the said Act, *vice* MR. W. J. JENKINS.

MR. M. VAIDYANATHAN, M.A., L.T., F.S.S., Statistician, Imperial Council of Agricultural Research, has been granted leave on average pay for four weeks with effect from the 13th May 1935.

MR. R. L. KAURA, M.R.C.V.S., has been appointed Assistant Serologist, Imperial Institute of Veterinary Research, Muktesar, with effect from the 12th April 1935.

DR. F. J. WARTH, D.Sc., I.A.S., Physiological Chemist, Bangalore, was granted leave on average pay for 7 days from the 16th March 1935, preparatory to retirement with effect from the 23rd March 1935.

From the 16th March 1935, and until further orders, MR. A. V. IYER, B.A., Assistant Physiological Chemist, Bangalore, has been appointed to hold charge of the current duties of the post of Physiological Chemist in addition to his own.

Madras

SAADAT-UL-LAH KHAN SAHIB BAHADUR, M.A. (Oxon.), Bar.-at-Law, I.A.S., Deputy Director of Agriculture, on return from leave, has been appointed to be Deputy Director of Agriculture, VI Circle, Madura.

MR. K. UNNIKRISHNA MENON, Dip. Agri., Officiating Deputy Director of Agriculture, Sixth Circle, has been granted leave on average pay for two and a half months from 1st April 1935 or date of relief.

MR. C. R. SRINIVASA AYYANGAR, L.Ag., Superintendent, Agricultural Research Station, Pattambi, and Assistant Director of Agriculture in charge, VI Circle, has been appointed to Class I, Madras Agricultural Service, and to officiate as Deputy Director of Agriculture, VI Circle, Madura, *vice* MR. K. UNNIKRISHNA MENON, granted leave.

MR. C. RAMASWAMI NAYUDU, B.A. (Cantab.), Assistant Director of Agriculture in charge, I Circle, has been appointed to Class I of the Madras Agricultural Service, and to officiate as Deputy Director of Agriculture, I Circle, Vizagapatam, *vice* MR. B. RAMAYYA, granted leave.

MR. C. V. SESHA ACHARYA, Assistant Director of Agriculture, Madura, has been granted leave on average pay for three months with effect from 24th April 1935.

MR. M. SURYANARAYANA, Assistant in Chemistry, has been appointed to Class I, Madras Agricultural Service, and to officiate as Assistant Agricultural Chemist, with effect from the 1st April 1935 or date of taking charge.

MR. T. R. VENKASWAMI RAO, Agricultural Demonstrator, Tiruvalur, has been appointed to Class I, Madras Agricultural Service, and to officiate as Assistant Director of Agriculture, Salem, with effect from the 23rd March 1935 or date of taking charge, *vice* MR. Y. G. KRISHNA RAO NAYUDU, appointed to officiate as Deputy Director of Agriculture, VIII Circle.

MR. A. GOPALAKRISHNAYYA NAYUDU, Officiating Assistant Director of Agriculture, II Circle, Guntur, has been appointed to officiate as Temporary Superintendent, Livestock Research Station, Hosur, with effect from 1st April 1935, or date of taking charge, *vice* MR. T. MURARI, appointed to officiate as Deputy Director of Agriculture (Livestock).

MR. C. VENKATRATNAM CHETTI, District Veterinary Officer, Bezwada, has been granted leave on average pay for two months from 1st May 1935.

Mr. R. Swaminaltha Ayyar, Veterinary Assistant Surgeon in the selection grade and probationer in the Madras Veterinary Service, has been appointed to be acting District Veterinary Officer, Bezwada, *vice* Mr. C. Venkatratnam Chetti, granted leave.

Bombay

Dr. W. Burns, D.Sc., I.A.S., Director of Agriculture, has been granted leave on half average pay for six months and six days in continuation of the leave already granted to him.

Mr. V. G. Gokhale, L.Ag., I.A.S., Professor of Agriculture and Principal, Agricultural College, Poona, has been granted leave on average pay out of India for seven months with effect from 23rd April 1935.

Dr. G. S. Cheema, D.Sc., I.A.S., Horticulturist to Government, Bombay, has been appointed to act as Principal, Poona Agricultural College, in addition to his own duties, *vice* Mr. V. G. Gokhale, proceeding on leave.

Mr. R. Y. Hulkoti, Cotton Superintendent, Dharwar, has been appointed to act as Professor of Agriculture, Poona Agricultural College, *vice* Mr. V. G. Gokhale.

Mr. K. S. Kulkarny, Assistant Professor of Agriculture, Poona Agricultural College, has been appointed to act as Cotton Superintendent, Dharwar, *vice* Mr. R. Y. Hulkoti.

Mr. A. R. Neginhal, Superintendent, Agricultural College Farm and Lecturer in Agriculture, has been appointed to act as Assistant Professor of Agriculture, Poona Agricultural College, *vice* Mr. K. S. Kulkarny.

Rao Bahadur D. L. Sahasrabuddhe, M.Ag., M.Sc., Agricultural Chemist to Government, has been granted leave on average pay out of India for eight months with effect from 15th April 1935 or the subsequent date of relief.

MR. N. NARAYANA, M.Sc., A.I.I.Sc., has been appointed to act as Agricultural Chemist to Government, Bombay, *vice* RAO BAHADUR D. L. SAHASRABUDDHE, proceeding on leave.

MR. S. B. JADHAV has been appointed to officiate as Divisional Superintendent of Agriculture, Deccan Canals, *vice* MR. G. P. PATIL, pending further orders.

Bengal

Babu JAGADISH CHANDRA BASU, Head Assistant of the office of the Director of Agriculture, Bengal, has been appointed to act as Personal Assistant to the Director of Agriculture, Bengal, during the absence on leave of MAULVI SHAIKH ABDULLAH or until further orders.

United Provinces

MR. C. H. PARR, B.Sc. (Agri.), I.A.S., Deputy Director of Agriculture, Bundelkhand Circle, Jhansi, has been granted leave on average pay out of India for a period of 8 months with effect from 1st April 1935, or subsequent date of relief.

MR. C. MAYA DAS, M.A., B.Sc. (Edin.), I.A.S., Deputy Director of Agriculture, North Eastern Circle, Gorakhpur, has been transferred to Bundelkhand Circle, Jhansi, in the same capacity, *vice* MR. C. H. PARR, granted leave.

DR. S. B. SINGH, M.Sc., PH.D., Assistant Director of Agriculture, Bahraich, has been appointed to be Officiating Deputy Director of Agriculture, North Eastern Circle, Gorakhpur, *vice* MR. C. MAYA DAS, transferred.

LALA HARBHAJAN LAL, Deputy Director of Agriculture, Eastern Circle, Partabgarh, has been granted leave on average pay for 2 months and 15 days with effect from 1st April 1935, or subsequent date of relief.

MR. S. C. ROY, Assistant Director of Agriculture, Allahabad, has been appointed to be Officiating Deputy Director of Agriculture, Eastern Circle, Partabgarh, *vice* Lala Harbhajan Lal, granted leave.

Babu UMA SHANKAR, Member, Subordinate Agricultural Service, 1st grade, has been appointed to be temporary Divisional Superintendent of Agriculture, Allahabad, *vice* MR. S. C. ROY, appointed Deputy Director of Agriculture, Eastern Circle, Partabgarh.

MR. IMDAD ALI KHAN, B.Sc. (Agri.), has been appointed to be temporary Assistant Sugarcane Expert (Cane Agronomist) with headquarters at Muzaffarnagar, with effect from 14th December 1934.

CAPTAIN W. S. SMITH, M.C., Superintendent, Government Horticultural Gardens, Lucknow, has been granted leave on average pay for 3 months with effect from 1st May 1935, or date of relief.

MR. S. M. KAZIM, Garden Overseer, in charge Nazul Gardens, Fyzabad, has been appointed to be Officiating Superintendent, Government Horticultural Gardens, Lucknow, *vice* Captain W. S. SMITH, granted leave.

Punjab

SARDAR SAHIB SARDAR KHARAK SINGH, M.A., I.A.S., Deputy Director of Agriculture, Montgomery, has been granted leave on average pay for three months and nineteen days and in continuation leave on half average pay for one year, ten months and ten days, with effect from 25th September 1934 preparatory to retirement.

KHAN BAHADUR M. FATEH-UD-DIN, B.A., I.A.S., Deputy Director of Agriculture, Jullundur, has been granted leave on average pay for four months, with effect from 30th March 1935.

MR. HAMID GHULAM SADIK, B.A. (Oxon.), Extra Assistant Director of Agriculture, Jullundur, has been appointed in charge of the duties of Deputy Director of Agriculture, Jullundur, with effect from the 30th March 1935 in a temporary post created for the purpose and in addition to his own duties, *vice* Khan Bahadur M. FATEH-UD-DIN, granted leave.

On return from the leave granted to him MR. J. S. GULERI, M.A., LL.B., F.E.S., resumed charge of the post of Assistant Professor of Agricultural Economics, Punjab Agricultural College, Lyallpur, on the forenoon of the 29th January, 1935.

S. DALIP SINGH, Extra Assistant Conservator of Forests, attached to the office of the Chief Conservator of Forests, Punjab and North-West Frontier Province, has been appointed Extra Assistant Director of Agriculture (Fruit), Lyallpur, with effect from the 28th March 1935, on his services being placed at the disposal of the Agricultural Department.

DR. S. V. DESAI, B.Sc., PH.D. (Lond.), D.I.C., Sugarcane Mycologist, Imperial Institute of Agricultural Research, Pusa (Bihar), has been appointed Agricultural Bacteriologist, Lyallpur, in the Punjab Agricultural Service, Class I, on probation for two years, with effect from the 7th February 1935.

S. PRITAM SINGH DIOL, Officiating Agricultural Assistant, Fruit Section, Lyallpur, has been appointed Assistant Marketing Officer, Fruit, Lahore (on probation for one year), with effect from the 15th March 1935, in a temporary post created in the Punjab Agricultural Service for a period of five years.

S. KARTAR SINGH, L.AG., B.Sc. (Agri.), N.D.D., Officiating Associate Professor of Agriculture, Punjab Agricultural College, Lyallpur, has been appointed Marketing Officer, Punjab, Lahore, with effect from the 15th March 1935, in a temporary post created in the Punjab Agricultural Service, Class I, for a period of five years.

S. JALMEJA SINGH MAJITHIA, B.Sc. (Hons.), Extra Assistant Conservator of Forests, Kilba (Simla district), has been appointed Extra Assistant Director of Agriculture (Fruit), Lyallpur, with effect from the 9th March 1935, on his services being placed at the disposal of the Agricultural Department.

The under-named officers have been appointed to the Punjab Veterinary Service, Class I, with effect from the 23rd November 1934, on the terms and conditions applicable to that service and without prejudice to the question of seniority :—

1. LALA AMIN CHAND AGGARWALA, B.Sc. (Hons.), M.R.C.V.S., Professor of Animal Husbandry, Punjab Veterinary College, Lahore.
2. SAIYED RIAZUL HASSAN, M.R.C.V.S., P.V.S., Assistant to the Professor of Pathology, Punjab Veterinary College, Lahore, and at present working as Deputy Director, Imperial Veterinary Serum Institute, Izatnagar (U. P.).
3. MR. W. S. READ, Assistant Superintendent (Fodder), Government Cattle Farm, Hissar.
4. KHAN SAHIB KH. GHULAM HASSAN, P.V.S., Deputy Superintendent, Civil Veterinary Department, Lahore and Jullundur Divisions, Ferozepore.
5. SAIYED IQBAL ALI SHAH, M.R.C.V.S., Officiating Superintendent, Civil Veterinary Department, North-West Frontier Province, Peshawar.
6. LALA BAIJ NATH HANDA, B.Sc., M.R.C.V.S., at present officer under training at the Government Cattle Farm, Hissar.
7. SETH MOHAMMAD SARWAR, M.R.C.V.S., at present working as Veterinary Investigation Officer, Punjab.

LALA HARJAS RAI, Lecturer on Veterinary Science, Punjab Agricultural College, Lyallpur, has been appointed Assistant Marketing Officer, Livestock, Lahore (on probation for one year), with effect from the 15th March 1935 in a temporary post created in the Punjab Agricultural Service for a period of five years.

Burma

MESSRS. A. MCLEAN, B.Sc., I.A.S., and J. CHARLTON, M.Sc., F.I.C., I.A.S., Deputy Director of Agriculture and Principal, Agricultural College, Mandalay, respectively, are appointed to the Selection Grade of the Indian Agricultural Service with effect from the 1st April 1935.

MR. A. McLEAN, B.Sc., I.A.S., Deputy Director of Agriculture, Burma, has been granted leave on average pay for seven months and in combination therewith, study leave for one month with effect from 7th March 1935, or the subsequent date on which he avails himself of it.

MR. TUN YEE, B.A.S., Class II, Assistant Director of Agriculture, East Central Circle, has been appointed to hold charge of the duties of the Deputy Director of Agriculture, East Central Circle, in place of Mr. A. McLEAN, I.A.S., proceeding on leave.

MR. R. WATSON, N.D.A., I.A.S., Deputy Director of Agriculture, Southern Circle, Rangoon, has been granted leave on average pay for five months and in continuation thereof leave on half average pay for one month and twenty-one days, for a total period of six months and twenty-one days with effect from the 18th April 1935.

MR. MAUNG MAUNG, B.A.S., Class II, Assistant Director of Agriculture, has been appointed to hold charge of the duties of the Deputy Director of Agriculture, Southern Circle, *vice* MR. R. WATSON, proceeding on leave.

MR. D. T. MITCHELL, M.R.C.V.S., B.V.S., Director of Veterinary Services, Burma, has been granted leave on average pay for four months and six days with effect from the 25th May 1935 or the subsequent date on which he avails himself of it.

Bihar and Orissa

MR. DAULAT RAM SETHI, M.A., B.Sc., I.A.S., Director of Agriculture, Bihar and Orissa, has been granted leave on average pay for seven months with effect from the 4th April 1935.

LT.-COL. C. A. MACLEAN, M.B.E., M.C., M.A., B.Sc., I.A.S., Deputy Director of Agriculture, in charge of the Chota Nagpur Range, has been appointed to act as Director of Agriculture, Bihar and Orissa, during the absence, on leave, of MR. DAULAT RAM SETHI, I.A.S., or until further orders.

Babu DINANATH JHA, B.Sc. (Pat.), Assistant Director of Agriculture, Sepaya, has been appointed to hold charge of the Chota Nagpur Range during the absence, on deputation, of Lt.-Col. C. A. MACLEAN, or until further orders.

MR. BINDHYABASINI PRASHAD AKHAURY, B.Sc. (Agr.), a stipendiary in the Agriculture Department, has been appointed to be a temporary Assistant Director of Agriculture, Sepaya, during the absence, on deputation, of Babu DINANATH JHA, B.Sc. (Pat.), or until further orders.

The officers named below have been appointed on probation for two years to Class I of the Bihar and Orissa Agricultural Service :—

1. MR. HIRA LAL DATTA, B.A. (Cal.), M.Sc. A. (Cornel.), Deputy Director of Agriculture, promoted from the Bihar and Orissa Agricultural Service, Class II.
2. Babu BHUT NATH SARKAR, L.Ag. (Sabour), Deputy Director of Agriculture, promoted from the Bihar and Orissa Agricultural Service, Class II (on deputation as Senior Marketing Officer, Bihar and Orissa).
3. MR. H. W. STEWART, Agricultural Engineer, transferred from a special post.
4. M. MAHBUB ALAM, M.Sc. (Luck.), Economic Botanist to Government promoted from the Bihar and Orissa Agricultural Service, Class II, (on deputation as Rice Specialist from the 20th January 1932.)

Babu BHUT NATH SARKAR, L.Ag. (Sabour), Assistant Director of Agriculture in charge of the South Bihar Range, has been appointed temporarily to be Senior Marketing Officer, Bihar and Orissa, with effect from the date he assumes charge of the Marketing Scheme.

MR. HIRA LAL DATTA, B.A., M.Sc. A. (Cornell.), Assistant Director of Agri culture in charge of the Orissa Range, has been appointed to hold charge of the South Bihar Range during the absence, on deputation, of Babu BHUT NATH SARKAR, or until further orders.

RAI SAHIB JAGANNATH DE, Assistant Director of Agriculture, Cuttack, has been appointed to hold charge of the Orissa Range, *vice* MR. HIRA LAL DATTA, appointed to hold charge of the South Bihar Range, or until further orders.

MR. R. T. DAVIS, M.R.C.V.S., I.V.S., Principal of the Bihar and Orissa Veterinary College, Patna, has been granted leave on average pay for seven months, with effect from the 15th April 1935 or any subsequent date from which he may avail himself of it.

Major P. B. RILEY, M.R.C.V.S., I.V.S., Director of Veterinary Services, Bihar and Orissa, has been appointed to act as Principal of the Bihar and Orissa Veterinary College, Patna, in addition to his own duties during the absence, on leave, of Mr. R. T. DAVIS, I.V.S., or until further orders.

MR. MUHAMMAD ISMAIL MALIK, B.Sc., M.R.C.V.S., Special Officer in the Civil Veterinary Department, Bihar and Orissa, has been appointed on probation for two years, to the post of Deputy Director of the Civil Veterinary Department in Class I of the Bihar and Orissa Veterinary Service.

Central Provinces

MR. D. V. BAL, L.Ag. (Hons.), A.I.C., F.C.S. (London), Agricultural Chemist, Central Provinces, Nagpur, has been granted leave on average pay for eight months (out of India or Ceylon), with effect from the 3rd April 1935, or any subsequent date on which he is relieved of his duties.

MR. A. R. P. AYER, B.A., F.C.S., Extra-Assistant Director of Agriculture, attached to the Chemical Section, has been placed in charge of the current duties of the Agricultural Chemist in addition to his own, *vice* MR. D. V. BAL, granted leave, or until further orders.

On termination of the temporary appointment as Marketing Officer, Mr. J. S. GURJAR has been re-appointed as Officiating Extra-Assistant Director of Agriculture, with effect from the 1st May 1935, and has been posted to Akola.

On relief by MR. J. S. GURJAR, MR. N . GANGAKHEDKAR, Officiating Extra-Assistant Director, Akola, has been posted to Drug in the same capacity.

MR. C. M. SUBBANNAH MUDALIAR, Assistant Director of Veterinary Services, Chhattisgarh division, has been granted leave on average pay for three months and fifteen days, with effect from the 1st May 1935, preparatory to retirement.

On return from leave MR. RAHIMBUX, Assistant Director of Veterinary Services Jubbulpore division, has been reposted to that division.

On relief by MR. RAHIMBUX, MR. M. Y. MANGRULKAR, M.Sc., M.R.C.V.S., D.T.V.M. (Edin.), Assistant Director of Veterinary Services, Jubbulpore division, has been transferred to Nagpur and placed in charge of the Laboratory.

On relief by Mr. M. Y. MANGRULKAR, MR. P. S. NAIR, G.B.V.C., Assistant Director of Veterinary Services in charge of Laboratory, Nagpur, has been granted leave on average pay for two months.

MR. L. M. ROY, Veterinary Inspector, has been appointed to officiate as Assistant Director of Veterinary Services, Berar division, *vice* Rai Sahib GOURI SHANKAR SHRIVASTAVA appointed to officiate in the Central Provinces Veterinary Service, Class I.

Assam

Babu BENODE BEHARI DAS, B.Ag., Superintendent of Agriculture, Lower Assam Valley, has been placed on special duty in the office of the Director of Agriculture, with effect from the 2nd March 1935.

MR. L. K. HANDIQUE, B.Sc. Agri. (Edin.), Superintendent of Agriculture, has been appointed temporarily as a Marketing Officer, Assam, with effect from the 13th February 1935.

NEW BOOKS

On Agriculture and Allied Subjects

The Agricultural Evolution of a Yorkshire Village. By A. G. Ruston, D.Sc., B.A., D. Witney, B. Com. Pp. VI+459, and 74 figs. (London : Edward Arnold & Co., 1934. Price 25*s*.).

An Introduction to Plant Biochemistry. By Catherine Cassels Steele, M.A., B.Sc., Ph.D. Pp. VIII+356 and 12 figs. (London : G. Bell & Sons, Ltd. 1934. Price 15*s*.).

The Practice and Science of Bread-Making. By D. W. Kent-Jones, Ph.D., B.Sc., F.I.C. Pp. 184 and 36 plates. (Liverpool : The Northern Publishing Co., Ltd., 1934. Price 7*s*. 6*d*.).

Economic Plants. By E. E. Stanford, Ph.D., Professor of Botany, College of the Pacific. Pp. XVI+571, and 376 figs. (New York and London : D. Appleton-Century Co., Inc., 1934. Price 21*s*.).

Virus Diseases of Plants. By John Grainger. (Oxford University Press, London : Humphery Milford. 1934. Price 6*s*.).

A Summary of Food Laws and Regulations. By C. L. Hinton, F. I. C. Pp. VII+90. (London : The Nema Press Ltd., 33, Tothill Street, Westminster, S. W. 1. 1934. Price 21*s*.).

Practical Bacteriology : an Introductory Course for Students of Agriculture, By Andrew Cunningham, D.Sc. Second edition, revised and enlarged. Pp. VIII+203, and 26 figs. (Edinburgh and London : Oliver & Boyd, 1934. Price 7*s*. 6*d*.).

Small-Fruit Culture. By J. S. Shoemaker, B.S.A., M.S., Ph.D. Pp. XV+434, and 52 figs. (Philadelphia : P. Blakiston's Son & Co., Inc., 1012, Walnut Street, 1934. Price $3·50).

Special Manures for Garden Plants. By A. J. Macself. Pp. VIII+152, and 17 figs. (London : W. H. & L. Collingridge, Ltd., 1934. Price 3*s*. 6*d*.).

The Meteorological Observer's Handbook. Pp. VIII+169 ; 30 figs. and 32 plates. (London : H. M. Stationery Office, 1934. Price 5*s*.).

Introduction to Cytology. By Lester W. Sharp. (McGraw-Hill Publications in the Agricultural and Botanical Sciences.) Third edition. Pp. XIV+567. (New York and London : McGraw-Hill Book Co., Inc., 1934.) 30*s*. net.

Insect Physiology. By Dr. V. B. Wigglesworth. (Methuen's Monographs on Biological Subjects.) Pp. X+134. (London : Metheun and Co., Ltd., 1934.) 3*s*. 6*d*. net.

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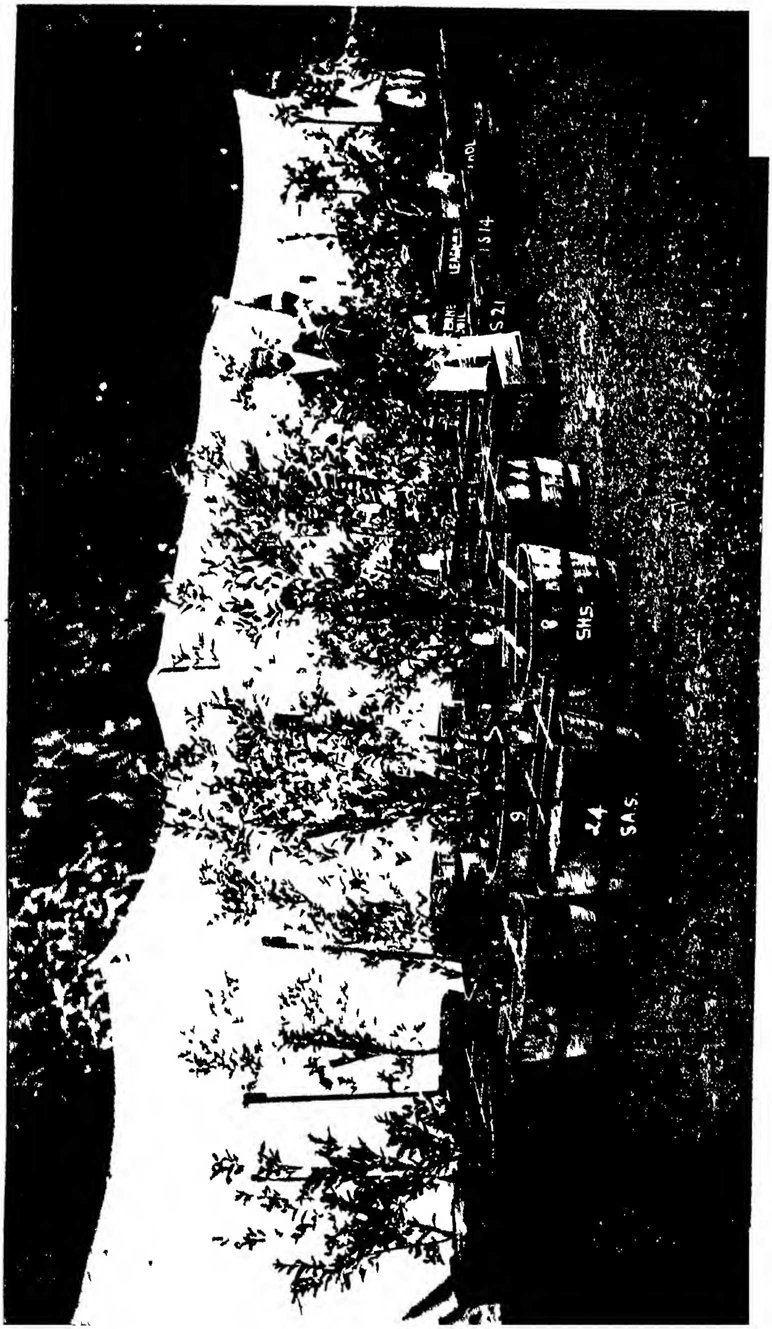

Testing the relation of soils to the growth of orange plants (Experiment conducted at Poona)

ORIGINAL ARTICLES

RECENT PROGRESS IN FRUIT-GROWING IN INDIA AND ABROAD*

BY

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The importance of fruit-growing.—Fruit-growing is an important source of wealth in several countries in the world. It is regarded as a money crop irrespective of whether the fruit is sold fresh or is converted into other valuable products. It provides both work and cash even under adverse economic circumstances and thus enables the farmer to meet liabilities which would otherwise weigh heavily on his holding. It is not surprising, therefore, that a tendency to encourage fruit cultivation has been apparent in all countries during the past decade. The mention of the monopolies in the fruit trade will give some idea of the importance and magnitude of fruit-growing in other countries. Italy, for example, specialises in the cultivation of citrus fruits and wine grapes and the world trade in Italian lemons is her monopoly. Her annual export of citrus fruits comes to about 301,000 tons. The French growers enjoy the privilege of specialising in the cultivation of certain wine grapes, and French viticulture is a great asset to the nation, and undoubtedly reflects credit on the ability of the growers who have held their position for ages. The total annual wine production of France amounts to 1,232 to 1,254 million Imperial gallons, out of which 15 million gallons are exported annually. Algeria is an important source of the French supply of wines. The Turkish fruit-growers, helped by their own natural resources and foreign exploitation, more than by scientific organisation, have a strong hold on the world market for their dried figs and sultanas, the export of which amounts to more than 75,000 tons annually. Though their fruit industry is of comparatively recent growth, the United States of America with their scientific ability, perseverance and organisation play a leading role in this field. Their annual exports amount to 238 million pounds of canned products, 13 million boxes of fresh fruit, and 365 million pounds of dried fruit. Spanish fruit growers also occupy a prominent place in the fruit trade, as Spain exports oranges and grapes annually to the extent of 931,000 tons. The annual export of Spanish oranges to the United Kingdom alone is 300,000 tons.

*This is the second of a series of popular articles for practical farmers on various agricultural subjects of general interest.

In many British possessions and Dominions such as West Indies, Palestine, South Africa, New Zealand, Canada and Australia, fruit-growing is being developed on scientific lines. Fair quantities of bananas, oranges and apples are shipped to the United Kingdom from British territories. The annual import of fruit into United Kingdom, however, amounts to £48,000,000 worth, inclusive of foreign imports, which come to 70 per cent. Countries like Iraq, Afghanistan, Persia, part of Russia and Japan also claim fruit-growing as a principal source of income to the agriculturist and are endeavouring to develop their fruit export.

In India the development of the fruit industry forms but a minor part of our agricultural activities, for, despite a vast range of soil and climatic conditions, fruit cultivation is not commercialised. Although India has some five million acres under fruit, she imported in 1933-34 fifteen lakhs worth of fresh fruit, 19 lakhs worth of almonds, currants and raisins, 36 lakhs worth of dates and 10 lakhs worth of canned and bottled fruit. Also other dried fruits and vegetables, for which classified details are not published, valued at 14 lakhs. Exports of fresh fruit only amounted to 4 lakhs worth. Exports of dried fruit and vegetables totalled 69½ lakhs, but fruit forms only a part of the total. The natural facilities and forces of India, suitable for this development are not properly harnessed, although there is a growing demand for fresh fruit and vegetables among her people, which can be noted by the steady increase in the imports of fruit. The total area of about five million acres under fruit and similar crops in India has remained practically steady for several years past and the expansion in acreage has not kept pace with the increased demand, which is now supplied by imports from abroad to an appreciable extent.

Research in fruit-growing.—A study of the development of fruit industry in various countries brings out the fact that research relating to fruit-growing deals with the following aspects of this industry :—

1. The breeding of suitable varieties to meet the commercial needs of the world.
2. The selection of proper root stocks, and the adoption of convenient methods of propagation to facilitate their distribution on a large scale.
3. Nutrition of fruit trees, pruning and cultural operations to get higher yield per unit area.
4. The improvement of transport and storage to reduce damage during movement and the sale period of fruit.
5. Methods of preservation by which surplus produce can be economically converted into more valuable products.
6. Pests and diseases which attack fruit trees and reduce their yield and economic value.

Where fruit-growing is an organised industry, every aspect of fruit cultivation is studied scientifically.

Fruit trade control.—In addition to the investigation of the above aspects of fruit-growing, trade control and legislation have played a prominent part in recent advances in fruit-growing. The benefits of the application of the results of researches are properly safe-guarded by appropriate legislative and administrative measures, with a view to protecting the industry against factors unfavourable to its growth. Such control tends :—

1. to safe-guard the industrial and economic interest of the people from foreign competition,
2. to check the introduction of harmful pests and diseases along with new varieties of fruits or in other ways, and
3. to maintain economic balance between the grower's expenses and risks and his profits.

Legal restrictions are now a regular feature of the trade control of fruit-growing in most countries. Legislation has indeed transformed fruit-growing conditions in some countries. The cultivation is neat. The handling of fruit is sanitary and the marketing properly organised.

Agricultural co-operation and fruit-growing.—Beside trade control, agricultural co-operation is acting as a powerful instrument in promoting the growth of the fruit industry in many parts of the world. Co-operative fruit-farming, co-operative manufacture of wines and preserves and the preparation of fruit for marketing through co-operation are the growing tendencies of the modern age. Agricultural co-operative facilities facilitate credit, secure specialised staff and obtain favourable terms for the disposal of the produce. The success of Jewish fruit colonies in Palestine, and the fruit-growers' societies and exchanges in the United States of America and Italy are instances where agricultural co-operation has shown profitable results.

The relation of co-operation to the well-being of the fruit industry is not fully realised in India. Recently, however, a few co-operative fruit sale societies have been registered, but they are not yet functioning properly.

The trend of recent investigations in foreign countries and India

Every fruit-growing country has contributed substantially towards the science of fruit-growing. The trend of investigations in France shows that the French workers have struggled to develop those types of grapes which would yield decidedly superior wines and help them to hold their monopoly. Aenological researches, coupled with the evolution of new types of grapes, root studies, fight against pathogens, soil fertilization and finding suitable methods of propagation, are the chief lines of experiment in France. All have a common object, *viz.*, to reduce the cost of cultivation and increase the yield in order to bring in more money to the growers. The French workers are also busy on the standardisation of packs suited to various types of fruit. Such improvements are

controlled by national committees and the French system of disposal of fresh fruit is skilfully organised.

The Italian Government is also busy improving the quality of fruit with the hope of establishing a wider trade in fruit products. Prompt attention is being given at present to diseases like the 'Mal del Secco' (caused by the organism *Deuterophoma tracheifila* Petri.) disease of citrus plantations, and relief is being given to needy growers by reducing their land tax and other liabilities. Rules and regulations are also being framed to control the import and export of fruit, with the hope of protecting their present industry. Foreign fruits cannot land so easily in Italy. Research on pomaceous fruits, genetics and the standardisation of lemon products form an important part of the Italian fruit work. Stress is being laid on the cultivation of nuts. At several places, the Italian growers have organised themselves in order to fight against pests of fruit trees.

Germany, though an industrial country, has contributed greatly towards the science of fruit-growing. Researches on plant growth and plant propagation, root studies, pollination, proprietory fertilizers and their effects on the quality of fruit-breeding and testing of new grape varieties and other such problems have attracted the attention of the German workers. The German observations on the technique of cold storage are very valuable.

The United Kingdom, being a great fruit-consuming country, is striving to develop fruit-growing in her territories with a view to reducing fruit import from foreign countries. Efforts to develop fruit-growing in British territories have been very successful. Researches on root stocks, soil deficiencies, gas storage and cold storage, and such other problems have helped the growth of fruit trade. The development of a canning industry has stimulated the extension of fruit cultivation in the British Isles. The findings of the Imperial Economic Committee (1926) emphasised the importance to fruit-growing in the Empire. The promulgation of pure food laws and the national marks scheme have enhanced the market value of British produce, whilst the activities of the Empire Marketing Board have developed the Empire fruit trade considerably. Empire fruits, by virtue of the various Ottawa agreements are admitted into the United Kingdom free of duty, whilst foreign fruits pay duty under the Import Duties Act, 1932.

The discussions at the Imperial Horticultural Conference, the establishment of the Imperial Bureau of Horticulture and of self-contained fruit experiment stations in the United Kingdom, as well as in other parts of the Empire, are some of the other important items which have led to the rapid progress of the fruit industry in the various parts of the British Empire. The recent List of Scientific workers in the Empire shows that almost every conceivable line of research is being pursued by one worker or another, in at least one part of the Empire.

The extension of fruit cultivation in various parts of the Empire is encouraging. The movement of fruit from one part of the Empire to the other is also brisk, and the development of the canning industry, specially in the United Kingdom, is phenomenal. All this success has been achieved within a decade. Plant-breeders all over the British Empire are keen on evolving suitable varieties of commercial fruits which will be useful for preserving and which can compete favourably with non-Empire products. The economic value of fruit research and organisation in the British Empire can be well judged from the volume of the trade from the West Indies to the United Kingdom and the rapid and successful establishment of the Jewish fruit-growing colonies in Palestine. Nor should one omit to mention the important researches on the 'Panama' disease of bananas in West Indies, and varietal trials, crop investigations in relation to soil and climate, cultural methods, plant diseases in South Africa, New Zealand and Australia.

In the United States of America the introduction and breeding of productive types of fruits are being actively pursued. Irrigation and pruning practices and use of fertilizers have undergone a great change. Their investigations relating to the improvement of transport, pre-cooling and storage of fresh fruit as well as canning are conducted on the more approved technical lines. Investigations on frozen pack, preservation of juices by freezing and colouring and softening of fruits by ethylene are considered valuable by the trade. The improvement of fruit crops by bud selection has been accomplished in recent years. Efforts are being made to find better stocks. The principles of evolving fruitful types by cross-pollination are well understood and practised. The State rules and regulations to control both the import and export and the internal movement of fruit and its products play as important a part as research does in the improvement of the American fruit industry. The development of mechanisation in agriculture has diminished the cost of production and has added materially to the profits of the commercial fruit farmer. The Fruit Bureau Section of the U. S. A. Department of Agriculture and the marketing and intelligence organisation add daily to the economic well-being of fruit-growers. The Government of the United States of America recently introduced a Bill to grant patents to holders of new varieties of fruit plants in order to give a stimulus to growers as well as plant-breeders to breed new types. The same policy is followed in her possessions in the Philippines and other islands.

Greece is also an important country from the point of view of fruit-growing as it specialises in currant grapes. The growing, manuring and drying of fruit have attracted the special attention of the Greecian growers. Greece exports 85,500 tons of currants and raisins annually.

It appears from recent reports and events that Japanese workers are closely following in the footsteps of investigators in other fruit-growing countries in the world. It is surprising to see that during the last three years the import of Japanese apple into the Indian market has increased from Rs. 704 in 1930-31

to Rs. 108,475 in 1932-33. Japanese researches on citrus crops are leading in many ways.

In India the fruit industry is still in its infancy. There is not much at present in this country which can be claimed as a valuable contribution towards the development of the fruit industry, either in the matter of research or of administrative measures. The importance and necessity of developing this industry have lately been attracting the attention of the agricultural mind. Both the Imperial and Provincial Governments are taking a lead in the matter and are financing fruit research schemes and establishing experimental stations. In Sind this activity is perhaps stimulated by the large irrigation projects in which huge sums have been invested and the move to develop wide tracts of the countryside where ordinary agricultural crops are not financially successful. Up to the present the work on the fruit crops done in India has chiefly consisted in introducing new varieties and giving them a trial under different soil and climatic conditions. Organised fruit research in India dates back to the last quarter of the nineteenth century, but the progress made so far is not encouraging. A survey of the work done shows that the earlier efforts were spasmodic and lacked that continuity which is so essential. It may be true that these attempts have but poorly subscribed to the economic development of the country, but the importance of the work should not be undervalued, as a beginning had to be made. The paucity of results is largely to be attributed to the fact that only now have self-contained experimental stations been established. Much effort is still needed in the way of developing productive varieties of fruits, improvements in propagation and cultural practices and researches relating to the utilisation of crops.

Progress of research and its application to industry requires both patience and finance. The success of the other countries mentioned above is the result of a long scientific struggle entailing large expenditure. In India fruit research has heretofore been of secondary importance in our agricultural development. It is a welcome sign, however, that in recent years some effort is being made to encourage the fruit industry in this country. Fruit has not yet played any part in the export of agricultural commodities on which, it is believed, India's economic prosperity depends so largely.

Looking to the history of the past decade one can safely say that the development of the Indian fruit industry shows a material advance. The first nucleus of this development is seen in the appointment of the Mango Marketing Committee in Bombay in 1925. This was followed by other important steps, which various Provincial Governments and the Imperial Government took to stimulate the growth of this industry. The Punjab Government organised their Fruit Section in 1926. The Government of Bombay showed their practical interest in the matter by permitting the writer to study the lemon industry in Italy and fig industry in Asia Minor in 1925. They also took the lead in exporting the Indian mango to England in 1932-33, with the financial help of the Imperial Council of

Agricultural Research, working out thereby the possibilities of this trade. They further convened two fruit trade and export conferences in 1933, soon after which the Bombay Fruit and Vegetable Marketing Committee was appointed to investigate the marketing of perishable products in this Province. In order to develop the Indian fruit trade, the Imperial Council of Agricultural Research in India further sanctioned a large amount of money for carrying out experiments to find out the "storage life" of different varieties of mangoes. The Council also finances fruit research schemes in Madras, United Provinces, Bengal, Bihar and Orissa, and in the Central Provinces; Punjab, Mysore and Hyderabad schemes have recently been approved. It remains to be seen what results emerge as a result of all these experiments and investigations, but it is hoped that the persistence of Indian investigators and their devotion to this cause will be rewarded by better yields and by the opening of better prospects for the development of the fruit industry.

It is satisfactory to note that material advances have been made recently in the organisation of fruit growers' associations in the Bombay Presidency, the Punjab and the United Provinces. The reduction of railway freight declared by the G. I. P. and B. B. and C. I. Railway Companies on perishable products is another helpful step. Such reductions are badly needed for the development of fruit industry as they give a great impetus to its growth by raising the growers' profits. A fillip has been given to fruit-growing and big fruit orchards managed on modern lines are cropping up in different parts of India and fruit-growing methods are undergoing a change for the better. Our hunt for improved types is also meeting with success. Indian-made fruit products, notably lime juice and jams, are daily gaining ground in the market. Projected schemes relating to the establishment of a fruit bureau and canning laboratories will provide missing links in the chain of progress.

It is thus evident that the ground has been cleared for the development of the fruit industry in India, and it should not take long for Indian investigators to bring their work into line with the requirements of the industry. Their co-operation with each other as well as the co-ordination of inter-provincial activities will result in improving the resources of the fruit-growers throughout India. Given State protection to the industry, complete agricultural experiment stations, proper marketing organisations and transport facilities, fruit-growing in India is bound to be an important source of wealth to the Indian agriculturist as in other countries.

STUDY OF THE VARIOUS STANDARDS ADOPTED FOR THE EXAMINATION OF INDIAN BUTTER AND GHEE

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Butter and ghee are two of the most important articles of food used in Indian dietary. Butter is not so much used as ghee because of its unsuitability in cooking of Indian foods and short-keeping qualities due to climatic and other factors; hence, it is generally made or purchased only for converting it into ghee. Butter is generally prepared in India by curdling the milk with lactic acid bacilli, and after collecting it for several days, the whole mass of curdled milk is then churned by a method which is peculiar to India, a method which dates back to the earliest Vedic period. Ghee is then made from butter thus prepared by heating it in an earthen or metal vessel on an open fire, and after removal of water, cooled and strained. As the demand for ghee far exceeds the supply, gross adulteration of it is being carried on by the ghee traders and one is hardly able to purchase genuine ghee from the market. Different municipalities and corporations in India are trying their best to check this gross adulteration of ghee, and various standards are adopted by them for this work. Unfortunately, the important physical and chemical constants for butterfat, *e.g.*, the Reichert-Meissl value and Refractive index vary between very large limits, depending upon the climatic conditions, food given to the animal, breed of animal, kind of animal, etc., which makes the work of ascertaining the purity of butterfat very difficult. In England, the great bulk of butter is prepared from milk of large herds of cows only, so that the effect on the Reichert-Meissl value of a single abnormal cow is very small. In India, on the other hand, large quantities of ghee are being prepared by small stock owner, owning only one or two cows or buffaloes, generally half starved animals kept under unhygienic conditions. When such samples of ghee are examined in the laboratory, the Reichert-Meissl values are found to be as low as 14·15 in some cases, on the other hand, samples of ghee obtained from buffaloes have Reichert-Meissl values over 30 [Howley, 1933]. It is thus evident

that the Public Analyst in India is always faced with this difficult problem when he receives a sample of ghee having a Reichert-Meissl value in the neighbourhood of 20. From the examination of the methods employed it is found that most of the municipalities and corporations in India pay great importance to the Reichert-Meissl value and the Refractive index reading, as these are the only characteristic values which can be performed in a simple and quick manner in the examination of the adulteration of ghee.

A large volume of work is being done in Western countries on this subject and various workers have carried on investigations of butterfat from different standpoints of which the following may be mentioned.

Hilditch and Sleightholme [1930] in their work on the variations in the component fatty acids due to seasonal and feeding conditions gave the following analytical characteristics of five samples of butterfat obtained from pasture-fed New Zealand cows.

Butterfat	Saponification value	Iodine value	Reichert-Meissl value	Polenske value	Kirschner value	Refractive index n_D^{60}
I . . .	253·3	41·3	29·6	1·9	23·7	1·4477
II . . .	242·7	31·6	29·3	3·2	23·7	1·4450
III . .	243·3	34·8	32·3	2·0	25·5	1·4455
IV . . .	248·2	41·6	25·7	2·2	20·6	1·4473
V . . .	242·2	34·5	30·3	2·3	24·7	1·4462

Dean and Hilditch [1933] studied the factors which influence the component fatty acids of butter and showed the variations in the iodine value and Reichert-Meissl value of milk fats of cows fed on pasture during summer and indoor feed during winter. They showed that the iodine values were higher in the butter fat of pasture-fed cows (45·0) than those of the same cows kept under indoor winter conditions (40·5). This was *vice versa* in the case of Reichert-Meissl values and was found to be 29·6 during winter-fed and 24·7 during summer-fed.

Stathopoulo [1933] gave analytical values of genuine samples of sheeps' and goats' butter which did not vary very much from the values obtained from cows' butter.

Bhattacharya and Hilditch [1931] in their work on fatty acids and component glycerides of Indian ghee gave the analytical characteristics which were as follows :—

	Saponification value	Iodine value	Reichert-Meissl value	Polenske value	Kirschner value	Refractive index n_D^{60}
Murrah buffaloes' ghee .	252·3	32·5	28·0	1·4	24·6	1·4467
Pasture-fed buffaloes' ghee	251·0	33·5	30·9	2·2	25·6	1·4462
Cross-bred cows' ghee	252·0	35·2	25·2	1·4	20·9	1·4475
Pasture-fed cows' ghee .	249·2	36·0	26·0	1·9	20·6	1·4470

Various workers have studied the effect of keeping, and therefore presumably the action of rancidity, on the Reichert-Meissl, Polenske and Kirschner values, and have found that some samples of butter increase in their Reichert-Meissl value with age, and some lose, but that, on the whole, the losses are greater than the gains [Elsdon, Taylor and Smith, 1931], [Rudcliffe and Maddocks, 1907], [Crispo, 1911].

The names of a few other workers may also be mentioned here in connection with their study of the analytical characteristics of ghee : Bolton and Revis [1911], Trimen [1913] and Ghose [1920].

Experimental

This work was undertaken by the authors with a view to finding out exactly the limits of variation of these important analytical values of genuine butter and ghee made in India. The samples examined in this paper were genuine ghee samples obtained from villages from producers direct, some from the market and the others produced under controlled conditions. Ghee or butterfat samples were prepared for examination by melting the samples, separating the fat by decantation, drying at 100-110° C. for 2 hours and finally filtering.

The following characteristic determinations were made on all the samples whose values are given in this work :—

Moisture.—This was determined by heating 2 grms. of each sample in an oven at 100-110° C. for 3 hours, and finding the loss in weight due to moisture.

Saponification value.—This was determined by refluxing about 1·5 grm. of each sample with $N/2$ alcoholic potash for half an hour and titrating the excess of potash with $N/2$ HCl. This value is expressed in milligrams of potash that is equivalent to one gram of fat.

Iodine value.—This was determined by the standard Wiz's method as given by Freyer and Weston and represents a measure of the unsaturated bonds present in the fat.

Reichert-Meissl, Polenske and Kirschner values.—These values were determined by the standard method given by the A. O. A. C. The Reichert-Meissl value represents a measure of the water-soluble volatile fatty acids (*i.e.*, low molecular weight acids, mostly butyric and caproic), the Polenske value is a measure of the water-insoluble volatile acids (chiefly caprylic, capric and lauric), while the Kirschner value is a measure of butyric acid.

Refractive Index.—This was carried out at 40°C. in an Abbe's refractometer and the reading transformed to butyro-refractometer reading from standard tables given in analytical books.

Acid value.—About 2 grms. of the sample was dissolved in hot neutral alcohol and titrated directly with $N/10$ NaOH which gave the free acid present in the fat and expressed in milligrams of potassium hydroxide required to neutralise the free fatty acids in one grm. of fat.

Analytical results

The analytical results of the various classes of ghee samples examined are given below.

(*a*) The samples (unsalted) obtained from the Imperial Institute of Animal Husbandry and Dairying, Bangalore, were produced under controlled conditions and were from representative milk of individual breeds of animals, namely, Sindhi, Gir, and half-bred cows and Murrah buffaloes. The following results of analysis were obtained :—

	Moisture percentage	Refractive index at 40° C. Butyro-refractometer reading	Reichert-Meissl value	Polenske value	Kirschner value	Saponification value	Iodine value	Acid value
Sindhi cow –								
I . .	0·1	44·1	26·8	1·9	22·5	223·6	35·8	0·56
II . .	0·1	43·6	25·9	1·6	22·4	222·4	35·5	0·56
III . .	0·2	44·1	25·8	1·9	22·4	224·3	36·7	0·44
IV . .	0·1	44·0	26·1	1·8	22·6	223·9	36·4	0·56

	Moisture percentage	Refractive index at 40° C. Butyro-refractometer reading	Reichert-Meissl value	Polenske value	Kirschner value	Saponification value	Iodine value	Acid value
Gir cow—								
I . .	0·1	43·0	25·6	1·8	22·4	223·7	36·7	0·56
II . .	0·1	43·7	26·3	1·9	22·4	223·1	36·5	0·72
III . .	0·1	43·5	25·9	1·9	22·5	222·8	36·5	0·56
IV . .	0·1	43·7	25·6	1·8	22·6	222·9	36·2	0·56
Half-bred cow—								
I . .	0·2	43·7	26·9	1·7	22·3	226·5	36·5	0·44
II . .	0·1	43·0	26·4	1·9	22·5	227·8	34·9	0·56
III . .	0·1	43·5	28·5	1·9	22·7	226·9	35·5	0·56
IV . .	0·1	43·2	27·6	1·9	22·5	228·5	36·1	0·44
Murrah buffalo—								
I . .	0·1	43·5	34·7	1·5	30·9	231·5	30·4	0·30
II . .	0·1	43·0	34·5	1·3	30·7	231·9	32·8	0·30
III . .	0·1	43·5	32·6	1·6	30·1	231·2	31·5	0·42
IV . .	0·1	43·0	33·7	1·4	30·5	232·1	31·0	0·30
Imperial Institute butter (Mixed herd)—								
I . .	0·2	43·3	29·1	1·8	23·5	225·3	34·5	0·56
II . .	0·2	43·0	28·8	1·7	23·0	226·5	34·1	0·56

(*b*) Representative milk samples from various breeds of Indian cows and buffaloes were obtained for four successive days from different herds in India and ghee prepared from the same. The analytical results obtained are given below :—

	Moisture percentage	Refractive index at 40°C. Butyro-refractometer reading	Reichert-Meissl value	Polenske value	Kirschner value	Saponification value	Iodine value	Acid value
Kangiam cows .	0·2	43·5	25·5	1·5	24·9	223·7	36·8	0·56
Sonchori cows . .	0·1	44·4	20·1	1·4	17·0	221·7	35·3	0·98
Tharparkar cows .	0·1	45·1	26·6	2·2	21·7	223·8	36·5	1·10
Hariana cows . .	0·1	43·8	26·0	1·5	21·6	224·0	36·0	0·98
Konkrej cows . .	0·2	43·5	26·1	2·0	21·5	230·0	34·2	0·72
Dhanni cows . .	0·1	43·5	26·5	2·3	21·8	225·1	35·9	1·40
Assamese cows. .	0·1	44·0	22·6	1·3	19·4	223·4	36·5	1·90
Ayrshire cows . .	0·1	43·5	25·7	1·8	22·6	220·4	37·9	0·72
Nagpuri buffaloes .	0·1	45·1	31·0	1·0	28·6	229·0	33·6	0·44
Surti buffaloes	0·1	44·0	31·7	1·1	28·9	230·6	33·0	0·56

(*c*) Two village samples of genuine butter and ghee were obtained from buffaloes kept purely on village grazing in an interior village called Chandanhalli in Kunigal *taluk*, and the following results were obtained :—

	Moisture percentage	Refractive index at 40° C	Reichert-Meissl value	Polenske value	Kirschner value	Saponification value	Iodine value	Aci val
Village buffaloes' butter (pasture-fed) .	0·1	42·7	31·9	1·5	26·8	230·4	32·5	0·
Village buffaloes' ghee (pasture-fed) .	0·1	43·5	31·6	1·5	26·6	229·6	32·6	0·

(*d*) Three samples of popular brand of salted tinned butter sold on the Indian market were analysed and gave the following results :—

	Moisture percentage	Refractive index at 40° C.	Reichert-Meissl value	Polenske value	Kirschner value	Saponification value	Iodine value	Acid value
Sample A . . .	0·1	45·1	26·9	0·9	23·2	226·1	35·2	2·5
Sample B . . .	0·2	43·4	32·0	1·7	29·1	225·3	33·5	2·4
Sample C . . .	0·1	43·7	25·7	1·3	23·1	224·1	36·7	3·1

(e) Representative samples of pure butter and ghee from different villages in the Madras Presidency on analysis gave the following values. From each village samples were received on successive days and the figures represent the mean of these values.

Places from where ghee samples were obtained	Moisture percentage	Refractive index at 40 ° C.	Reichert-Meissl value	Polenske value	Kirschner value	Saponification value	Iodine value	Acid value
Tadapatri . .	0·2	43·0	29·6	1·3	26·0	223·8	30·4	2·9
Kondapuram. . .	0·2	42·8	31·5	1·7	28·8	218·1	37·4	2·6
Jammalmadgee .	0·1	42·9	29·3	1·2	26·4	224·7	35·0	2·7
Proddatur . .	0·2	42·8	30·3	1·7	27·2	222·9	35·3	2·3
Darapuram . .	0·2	43·0	25·1	1·3	22·4	221·8	36·5	3·0
Ongole . . .	0·2	43·0	34·6	1·6	30·8	231·4	34·5	2·5
Tennali . . .	0·1	43·0	26·6	1·2	22·3	223·8	35·7	2·7
Repalli . . .	0·1	42·9	28·5	1·3	26·1	223·3	34·2	2·3
Gudivada . .	0·2	42·8	24·0	1·4	22·0	218·6	35·8	2·0
Tanuku . . .	0·1	43·4	25·5	1·2	23·0	227·7	34·8	2·2
Sattlur . . .	0·1	43·0	26·1	1·3	23·8	222·8	35·4	2·2

Discussion

In the Punjab the values adopted in the municipalities and government laboratories generally for testing the purity of ghee and fat of butter are that the samples should have less than 2·8 per cent of free fatty acids, butyro-refractometer reading at 40° C. should not be less than 40 and not more than 42·5 and that the Reichert-Meissl value should vary between 24 and 32.

The Madras municipal standards require the ghee to contain less than one per cent water. Samples of ghee or fat in butter giving Reichert-Meissl values below 20 are condemned by this municipality, and those above 30 are passed as genuine, while the refractive index is used as a check if the Reichert-Meissl value vary between 20 and 30.

The Central Provinces Government have laid down the limits of the Reichert-Meissl values between 19 and 36 for genuine ghee and butyro-refractive index at 40°C. between 40 and 46 and have prescribed that the fat in butter should conform to standards laid down for ghee.

No fixed standards for butter and ghee are set up by the Government of Bombay, but they are included in the proposed amendment of the Prevention of Adulteration Act, 1925, which at present is under consideration. The minimum Reichert-Meissl value of 28 is laid down by the Army Specification, and is also adopted by the Health Officer of the Port of Bombay.

The Local Self-Government Department of the Government of Bengal has specified the standards of butter and ghee and require a butyro-refractometer reading at 40°C. of not more than 40 and not less than 42·5. In the case of cow ghee the saponification value of not less than 220 and a Reichert-Meissl value of not less than 24, and in the case of buffalo ghee, the saponification value of not less than 222 and a Reichert-Meissl value of not less than 30 are laid down. They further require a saponification value of not loss than 222 and a Reichert-Meissl value of not less than 28 in the case of mixed cow and of buffalo ghee.

The Government of Bihar and Orissa have specified the standards for pure ghee and fat of butter, and requires the butyro-refractometer reading at 40°C. to be between 40 and 42, with a Reichert-Meissl value of not less than 24 in the case cow ghee, not less than 30 in the case of buffalo ghee and not less than 28 in the case of mixed cow and buffalo ghee.

Observations

In the above specifications of various governments and municipalities it can be seen that quite discrepant values have been adopted for passing the genuine butter and ghee. From the experimental results of a great number of samples of pure Indian butter and ghee analysed in this work, quite definite figures can be obtained which are given below :—

(1) The moisture content in the ghee samples was found in all the cases to be varying between 0·1 and 0 per cent. The limits of this value as given by the municipalities generally can be said to be too high and after making a little allowance, one can definitely put down the limit of water content in ghee samples to be below 0 per cent.

(2) The butyro-refractometer readings at 40°C. observed from the experiments do not vary as much as the Reichert-Meissl values. The minimum reading obtained from the above experiments is 42·8, while the maximum is 45·1. The limits may be easily laid down between 42·0 and 45·5 for both cows' and buffaloes' ghee.

(3) The Reichert-Meissl value as seen from the experiments show a minimum of 20·1 and a maximum of 28·5 in the case of cow ghee, while in the case of buffalo ghee the values are over 31·0. It has not been found feasible to set up different standards for buffaloes and cows' ghee, as they are generally obtained only in mixed condition. Hence a standard minimum Reichert-Meissl value of 20 can be laid down for the passing of genuine sample of ghee.

(4) The Polenske values show a minimum of 0·9 and a maximum of 2·3 and for standardisation of this value a maximum of 2·5 can be suggested.

(5) The Kirschner value which is an important analytical characteristic for the testing of butter and ghee varies in the above experiments between 17·0 and 30·8, and for specification, it can be laid down to be more than at least 16·0.

(6) The saponification values observed show a minimum value of 218·1 and a maximum of 231 and laying down a standard for the ghee, it should always be more than 218·0.

(7) The iodine values were found to vary between 30·4 and 37·9 and for specific limitation in genuine butter and ghee, the values should vary between 30 and 38.

(8) The acid value which is approximately double the percentage of free fatty acids (calculated as oleic) show a maximum of 1·9 and for specification in testing genuine fairly fresh samples of ghee the percentage of free acids should not be more than 1 per cent.

RECOMMENDATION OF STANDARDS FOR GHEE AND BUTTER FOR ADOPTION

Moisture content—Less than 0·7 per cent (in case of ghee only).

Butyro-refractometer reading—Between 42 and 45·5 at 40°C.

Reichert-Meissl value—Not less than 20.

Polenski value—Not more than 2·5.

Kirschner value—Not less than 16.

Saponification value—Not less than 218.

Iodine value—Between 30 ond 38.

Free fatty acids—Less than 1 per cent.

The authors wish to express their gratitude to Professor V. Subrahmanyan for his constant interest and helpful criticism during the course of this work, which was carried out with the co-operation of the Indian Institute of Science, Bangalore.

REFERENCES

Bhattacharya, R. and Hilditch, T. (1931). *Analyst*. **56**, 161.

Bolton and Revis (1911). *Analyst*. **36**, 392.

Crispo, D. (1911). *Analyst*. **36**, 64.

Dean, H. and Hilditch, T. (1933). *Biochem. J.* **27**, 889-897.

Elsdon, Taylor and Smith (1931). *Analyst*. **56**, 515.

Ghose, T. K. (1920). *Analyst*. **45**, 444.

Hawley, H. (1933). *Analyst*. **58**, 529.

Hilditch, T. and Sleightholme, J. (1930). *Biochem. J.* **24**, 1098.

Redcliffe and Maddocks (1907). *J. Soc. Chem. Ind.* **26**, 3.

Stathopoulo, T. (19[illegible]). *J. Pharm. Chim.* **125**, 287-289.

Trimen, (1913). *Analyst*. **38**, 242.

LIFE-HISTORY OF GRAM BLIGHT [*ASCOCHYTA RABIEI* (PASS) LAB=*PHYLLOSTICTA RABIEI* (PASS) TROT. ON GRAM (*CICER ARIETINUM* L.)] AND ITS CONTROL IN THE PUNJAB

BY

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CONTENTS

I. Introductory

In the Punjab gram is one of the most important crops that are grown in tracts which depend on rainfall for supply of soil moisture. Next to wheat, it occupies the greatest area of about four million acres (including the Indian States the area is about 5½ million acres).

In some parts of the Province the gram crop has been subject to the attack of a very destructive disease caused by the fungus *Ascochyta rabiei* (Pass) Lab.= *Phyllosticta rabiei* (Pass) Trot. and commonly known as gram blight. The disease has frequently broken out in an epidemic form particularly in the Attock and Jhelum districts. The figures of the area sown and matured in the Attock tahsil for the years 1920-30 show that on an average 50 per cent of the crop was destroyed by the disease annually. From these figures it has been estimated that on account of this disease, the financial loss suffered by farmers in the Attock district alone amounts to about one million rupees every year. The disease also occurs in Gurdaspur, Gujrat, Mianwali and Rawalpindi districts to a small extent.

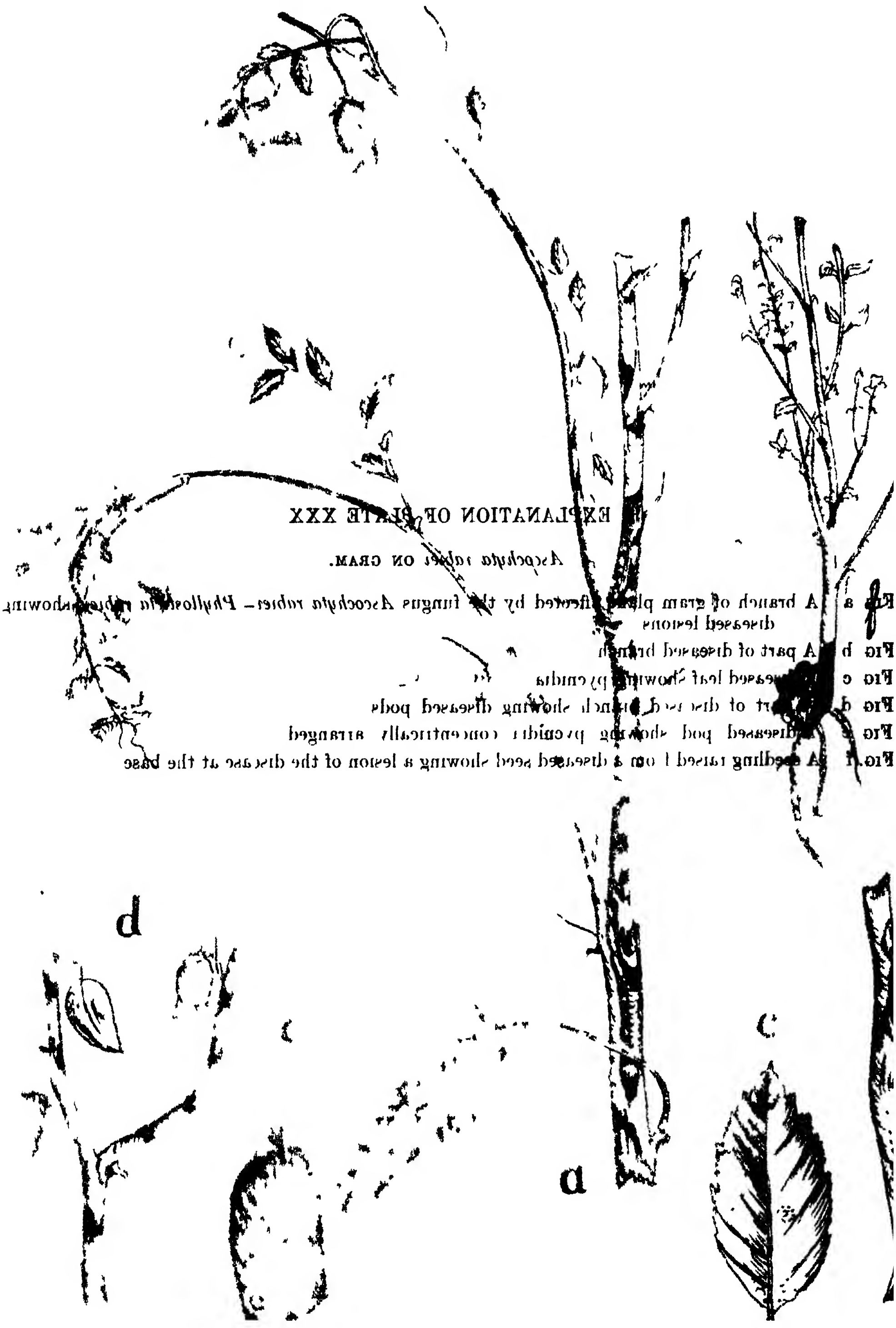
Outside the Punjab, the blight has been reported in India from the North-West Frontier Province only.

On account of the seriousness of the disease a systematic study of the problem was undertaken. For this purpose a field laboratory was set up at the Agricultural Farm, Campbellpur, and experiments were conducted in the centre of activity of the disease in addition to the laboratory and field experiments carried out at Lyallpur. Data already published by the authors [Luthra and Bedi, 1932]; [Sattar, 1933 and 1934] elsewhere on the blight disease have also after confirmation been made use of in the preparation of this paper, which gives a popular account of the work done.

II. Symptoms of the disease

All the above-ground parts of the plant are attacked by the fungus. Brown to dark spots varying in size appear on leaves, petioles, stem, and pods. These spots are circular on leaves and pods and elongated on stems and petioles. Pycnidia (spore bodies of the fungus) appear on the diseased spots as dark brown dots. These are concentrically arranged on pods and other parts exposed to light. Generally the spots encircle the stem completely and parts of the plant above the lesions droop down and dry up. In case spots are formed at the base of the plant, the whole plant withers. The terminal portions of shoots are very readily attacked and dry up. A diseased plant is shown in Plate XXX.

In early stages of growth of the crop, affected plants cannot be distinguished from a distance. From February onwards affected plants can be easily spotted due to total or partial drying up of the shoots. At first individual diseased plants may be observed scattered here and there, but later the disease spreads in a circle and patches of attacked plants become prominent. The affected plants completely dry up and assume brown colour as if scorched by fire. Therefore, patches of dead plants become conspicuous in the field. If the weather during the flowering and fruiting period, *i.e.*, from February to April, remains dry, the disease remains restricted or spreads slowly, but if moist conditions prevail, the whole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crop generally gets involved as a result of secondary infection and is completely destroyed in a few days. On the plants that survive till maturity, the blight spots develop with great vigour and rapidity. The pycnidia of the parasite appear on pods in abundance in characteristic concentric zones. The fungus penetrates through the surface of the pod and infects the testa as well as the cotyledons of the seeds within. Every stage may be found from that in which the seeds are not formed at all to that in which they mature successfully but bear a dark brown patch on the surface.

III. Cause of the disease

After a detailed study of the gram blight fungus isolated from diseased material collected from fields at Campbellpur it has been discovered that the fungus causing the disease in gram is quite distinct from a similar disease that attacks plants of beans, pea and lentil [Sattar, 1933]. The gram blight fungus has now been named as *Ascochyta rabiei* (Pass) Lab. = *Phyllosyticta rabiei* (Pass) Trotter.

IV. Description of the fungus

In a transverse section of the affected portion passing through a pycnidium (Plate XXXI) it is seen that the hyphae are hyaline to brown and septate. The pycnidium is spherical or pear-shaped with an opening, called the ostiole, at the top. These pycnidia contain numerous hyaline spores on short conidiophores (stalks) and embedded in a mucilaginous mass. When the pycnidia get wetted the mucilaginous mass on absorbing moisture, swells up and the spores ooze out automatically. The spores are oval to oblong in shape and measure $10\ \mu \times 4\ \mu$. When the spores are examined under dry conditions they are almost all (98 per cent) uni-cellular ; but under very moist conditions at the time of flowering and fruiting, they considerably swell and 5-10 per cent may become bi-cellular.

The optimum temperature for the growth of the fungus and germination of spores is 20°C. The maximum is about 32·5°C. and the minimum below 10°C.

V. Modes of perpetuation of the disease

The following methods have been found to be responsible for the carrying over of the disease from one season to the other :—

(1) Infected seed.

(2) Diseased plant debris which remains lying on the surface of the soil after the crop is harvested.

1. *Seed infection*.—In samples of seeds taken from a diseased gram crop every gradation is seen from apparently healthy and fully-developed seeds to those which are shrivelled and discoloured bearing large lesions on the surface. From such discoloured seeds whether slightly or severely affected, the fungus has been isolated by the usual culture methods. Severely infected and shrivelled seeds are not

viable and do not germinate. If the seeds show only small discoloured spots and are well developed they germinate, but a considerable number of the seedlings (in various experiments 50 to 90 per cent) bear the disease. The precise symptoms shown vary somewhat according to the climatic and other conditions. Thus the young seedlings on appearing above ground may show infection of the tip or any part of the young stem. In other cases no infection may be visible until the plants flower and bear fruit when the lesions of the disease appear on shoots as well as on pods.

Experiments have also shown that if seed mixed with pieces of infected gram plants is sown and the bed is fairly moist, the disease appears in the seedlings.

2. *Diseased plant debris.*—It has been generally observed that zamindars do not harvest the gram crop which is almost entirely destroyed by the disease, as practically no produce of grain is expected from it. Further, wherever the crop is cut, a great deal of the sticks bearing the disease are left over in the fields. The threshing floors also have been found strewn with diseased debris of gram plants. Laboratory culture tests have fully established that the fungus borne on remnants of plants left in the fields after harvest in April or May remains alive for more than two years while fully exposed to weather. During summer months the fungus remains in a dormant state but after the rainy weather when it becomes cooler, fresh pycnidia are produced on those parts of stalks which were originally free from them. In this way the amount of inoculum is increased. These new infections arise mainly by the germination of spores which are liberated from the old pycnidia by the action of rain or dew and also by the growth of mycelium which is inside the stalks. These observations show that the fungus lives as a saprophyte on gram stalks lying on the surface of soil during the summer period when there is no gram crop in the fields. It has further been observed that during excessive summer rains the pycnidia burst and the spores being thrown out are destroyed as the fungus cannot live in the soil. Thus the inoculum is much reduced by rain.

In order to ascertain if the diseased material referred to above would infect gram plants in the following season, inoculation experiments were made in the laboratory as well as in the field, by (*i*) spraying gram plants with suspension of pycnospores of the culture prepared from old gram sticks, (*ii*) spraying gram plants with suspension of pycnospores obtained from old gram sticks, and (*iii*) tying old diseased sticks to gram plants, during 1932-33 and 1933-34. These ex periments have given conclusive results to the effect that such diseased material is a very active source of infection for the next crop.

It may be mentioned that last three to four years' experiments have conclusively shown that the soil itself does not harbour the fungus.

Effect of burying diseased plant debris in the soil.—It has been conclusively found out by a series of experiments that when the diseased material is buried under

ground during summer months at a depth of two inches or more and there is enough moisture in the soil, the fungus is entirely killed and the remnants of the debris buried cannot infect the subsequent gram crop.

VI. Spread of the disease by secondary infection

As already described, the disease originates in the first instance from (*i*) the infected seed sown and (*ii*) the diseased debris lying exposed in the fields and threshing floors. These infection centres are limited and isolated in the beginning but they rapidly increase in number and extent. The diseased tissues of the primarily infected plants being brittle easily break off and are transported hundreds of yards by strong winds. Also when rain is accompanied by strong wind the spore suspension, which is formed by rain water falling on the diseased tissues, is splashed vigorously from plant to plant. Fresh infections are initiated in this way. If these conditions which promote secondary infection persist for sometime, infection gets widely spread and the entire gram crop is involved.

VII. Factors influencing spread and development of the disease

The environmental factors which are of importance are · (1) Rainfall, (2) Temperature, (3) Prevalence of winds and (4) System of cropping.

(1) *Rainfall.*—Rainfall during summer indirectly affects the incidence of blight. Heavy rainfall during this period washes the spore bodies off the gram stalks which remain lying on the surface of the soil and thus the inoculum is greatly reduced. Consequently there will be less infection in the next crop. The critical period as regards rainfall is, however, from February to April which covers the flowering and fruiting period. Observations made in the Attock tahsil have shown that gram blight appears in an epidemic form in those years only when rainfall during this period is above normal (about 6 inches). The occurrence of blight in the various districts of the Punjab seems to be correlated with the amount of rainfall as one of the factors. The figure, Plate XXXII, shows a map of the Punjab with the lines of 6 inches (A-A) and 3·5 inches (B-B) rainfall inserted. These lines divide the Province into three areas.

(*i*) North of the six inches line, where blight is serious and in certain parts often epidemic.

(*ii*) Between the lines A-A and B-B, where blight is reported from time to time but where it is not serious.

(*iii*) South of the 3·5 inches line where in some districts it may occur sporadically, but where the damage caused is insignificant. It is only where the spring rainfall is heavy, *e.g.*, Campbellpur and North-West Frontier Province that the disease is of importance.

(2) *Temperature.*—In as much as high temperature is generally associated with low rainfall and *vice versa*, it is obvious that temperature will show some relation to incidence of blight but the relationship in general is probably only

incidental. Nevertheless, temperatures above the maximum, *i.e.*, 32·5°C. for growth of the fungus will obviously prevent disease.

It has been found out by experiments that very few spores germinate and cause infection during the months of December and January due to very low temperatures, even though high humidity may prevail and there may be rain. The spores, however, remain viable and even can stand freezing temperature. As the season becomes warmer in February and March (70°—80°F.) the spores readily germinate and cause infection. This is one of the reasons that gram blight makes its appearance in these months.

(3) *Prevalence of winds.*—Though the fungus causing gram blight belongs to a family which does not produce the air-borne type of spores, winds nevertheless play an important part in the spread of the disease. This applies to winds both in dry and wet weather. With regard to the former, observations made in the affected locality during the last three years have shown that dried-up leaves and affected stems of diseased plants are blown away for hundreds of yards. These diseased parts bear abundant pycnidia of the fungus and when they lodge among the healthy plants, they act as a source of infection when rain sets in and weather becomes moist. In wet weather, wind is a potent agent for the dissemination of the fungus. In the case of heavy rains accompanied by strong winds the fields are enveloped with a fine mist which is blown over a large area. Under such conditions the spores which ooze out of the pycnidia are splashed about and carried away in suspension as had been shown by various experiments. Ideal conditions are created for spores to germinate and infect the plants. The disease continues marching on rapidly by secondary infection.

(4) *System of cropping.*—Observations for the last many years have shown that the gram crop sown in mixture with wheat, barley, *taramira* (*Eruca sativa*) or *sarson* (*Brassica campestris*) suffers less from the disease than the pure gram crop. This is evidently due to the fact that the fungus gets less chance for its spread as crops immune to it stand as barriers between gram plants. The system of mixed cropping also explains the difference observed in the incidence of the disease between certain areas which have practically similar climate, *e.g.*, Attock and Rawalpindi. The disease is more serious in the former than in the latter district. In the Attock district gram is generally grown pure on an extensive scale so that there is practically a continuous long stretch of land under this crop—a factor which facilitates the dissemination of the parasite.

VIII. Control measures

The following measures which on the basis of repeated experiments have been found to be effective and practicable for the control of the disease are recommended to the farmers—

(1) Use of healthy seed for sowing purposes

(2) Destruction of diseased plant debris which remains lying on the surface of the soil in the fields after harvest

(3) Growing of the gram crop mixed with wheat, barley, *taramira* (*Eruca sativa*) and *sarson* (*Brassica campestris*).

(1) *Use of healthy seed for sowing purposes.*—Since infected seed is one of the sources of perpetuating the disease, it is obvious that healthy seed should be used for sowing purposes. It has been found that the gram crop in the districts of Hissar and Ferozepore is free from blight. It is, therefore, recommended that seed to be sown in blight-affected areas should be obtained from these places. If, however, for reasons of cost of transport it is not possible to obtain healthy seed from these districts, it may be got from Sargodha, Lyallpur, etc., but in such cases, the seed must be tested for freedom from blight infection and only such seed which is certified free from the disease should be used for sowing purposes. A method has been devised and arrangements have been made in the Mycological Laboratory of the Punjab Agricultural College, Lyallpur, for undertaking such tests free of cost for the Department and public. The method is given below :—

The seed is disinfected in 0·1 per cent mercuric chloride solution for 5 minutes, then washed in sterilized water and incubated in tubes of oatmeal agar (oatmeal 50 grms., agar 10 grms. and water 500 c. c.) at 20°C. From infected seed, the gram blight fungus will grow and produce spores within seven to ten days whereas healthy seed will not produce any fungus growth.

(2) *Destruction of diseased plant debris lying on the surface of the soil in the fields* :—Experiments have proved that diseased plant debris is a very active source of infection, therefore it is essential that the remnants of the crop should be destroyed. All the following measures for this purpose have been found effective :—

(*a*) Harvesting by uprooting.—Observations have shown that if the gram crop is cut with sickle, many stalks are left in fields and if the crop is harvested by uprooting the plants, very few stalks are left behind. As generally where gram is grown, the soil is sandy and light, it is not difficult for the farmers to follow this method without incurring much extra labour. It was found out by a number of tests at the Agricultural Farm, Campbellpur, that where four men were required to harvest one acre of gram crop by sickle, only five men were needed to accomplish the operation by pulling the plants out with hand. In fields where the disease is very serious, the farmers give up the crop and do not harvest it. Such a crop must be pulled out by the roots and burnt.

(*b*) Cleaning of threshing floors.—The farmers generally make threshing floors in their fields and after threshing is over, all refuse, etc., which contain diseased pieces of plant is left in heaps all around the place. Such refuse should be collected and burnt or put in manure pits. It has been found that if such refuse is buried at a depth of about two feet in manure pits the fungus is killed in two to three

months. It has also been found that the fungus cannot survive the digestive tract of bullocks and therefore, if desired, the material can be fed to farm cattle.

(*c*) *Bhusa* should not be stacked in the fields.—Observations have shown that farmers stack gram *bhusa* in the fields and then cart it to villages during winter when gram crop is in the field. *Bhusa* contains diseased parts of plants that contain viable fungus. Experiments have proved that the diseased straw is capable of causing infection. During the process of carting, *bhusa* drops in the fields and becomes a very active source of infection for the spread of the disease. It is therefore recommended that *bhusa* should not be stacked in the fields.

(*d*) Use of furrow-turning ploughs.—Experiments have proved that if diseased gram sticks are buried in the soil during summer at a depth of two inches or more for one month, the fungus is killed provided there is enough moisture in the soil. Experiments have also shown that after the diseased crop has been harvested by uprooting with hand and the infected material has been picked up, furrow-turning ploughs, like the Meston, go a long way in reducing the amount of infection still further, because a large amount of the diseased remnants get buried underground. It is, therefore, recommended that the furrow-turning ploughs should be used after the first shower of rain in summer. If these operations are continued every year, the disease is bound to be eliminated.

(3) *Growing the crop in mixture with wheat, barley,* taramira (*Eruca sativa*) or sarson (*Brassica campestris*).—Observations during the last many years have shown that the incidence of disease in a mixed crop is much reduced as compared with pure crop. It is, therefore, recommended that wherever possible gram should be sown in mixture with other suitable crops in the affected localities.

As the disease spreads rapidly from field to field by secondary infection it is obvious that if some farmers follow the above instructions and others do not, the disease will continue to appear even in the fields of farmers who follow the instructions. It is, therefore, necessary that all the farmers in an affected locality should co-operate to stamp out the disease by concerted action. The Punjab Government has now issued an order for the Attock district where the disease is generally serious, to the effect that no remission or suspension of land revenue shall be granted for the failure of the gram crop on account of the blight disease, unless recommendations of the Punjab Agricultural Department are followed. The recommendations may be re-iterated in brief as follows :—

(*i*) Use of disease-free seed supplied by the Agricultural Department.

(*ii*) Elimination of diseased material from fields by—

(*a*) harvesting the entire gram crop by uprooting with hand and thus leaving fields free of infection,

(*b*) ploughing the fields once with the Meston plough after the first shower of rain in summer to bury the remnants of diseased plants,

(*c*) sweeping the threshing floors and burying or burning the collected debris, and

(*d*) not making *bhusa* stacks in the fields.

(*iii*) Mixed cropping.—Wherever possible gram crop should be sown mixed with wheat, barley or any other suitable crop.

These recommendations are being enforced by the Agricultural Department and the Revenue Staff of the Attock district and the farmers are taking them up. In 1933-34 more than 4,000 maunds and in 1934-35 about 6,000 maunds of disease-free seed was distributed in the affected locality, and threshing floors and fields were got cleaned up as far as possible. As a result of these measures very encouraging results were obtained. It may be pointed out in this connection that all the control measures noted above were also adopted at the Government Agricultural Farm, Campbellpur, during the past three years and a healthy crop of gram was produced.

IX. Summary

(1) The blight disease of gram is very serious in Attock and Jhelum districts of the Punjab.

(2) The symptoms of the disease have been described.

(3) The disease is caused by the fungus *Ascochyta rabiei* (Pass) Lab.-*Phyllosticta rabiei* (Pass) Trot.

(4) The maximum, optimum and minimum temperatures for germination of spores and growth of the fungus are 32·5°C., 20°C. and below 10°C. respectively.

(5) The disease is carried over from one season to the other by (*a*) sowing infected seed and (*b*) by the diseased plant debris which remains lying on the surface of the soil after the crop is harvested.

(6) The disease spreads from plant to plant and field to field by secondary infection carried by spores and the diseased parts of gram plants. The spores of the fungus are not blown by wind in dry weather.

(7) Factors, such as rainfall, temperature, wind and system of cropping, which affect the spread and development of the disease during the growing season, are described.

(8) The following measures have been found effective for the control of the disease and are recommended to farmers :—

- (*a*) Use of disease-free seed.
- (*b*) Elimination of diseased plant debris by—
  - (*i*) Harvesting the crop by pulling out the plants with hand.
  - (*ii*) Ploughing the fields once with a furrow-turning plough after the first shower of rain in summer to bury the remnants of diseased plants.
  - (*iii*) Sweeping the threshing floors and burning or burying the collected debris.
  - (*iv*) Not making *bhusa* stacks in fields.
- (*c*) Mixed cropping of gram, with wheat, barley, etc.

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IX. References.

Atanasoff, D. and Kovacevski, I. C. (1929). *Bull. Soc. Bot. de. Bulgarie.* **3**, 45—52.

Canizo, D. J. (1927). *Bol. Pat. Veg. Y. Ent. Agric.* **2**, 10—14.

Labrousse, F. (1930). *Rev. Path. et Ent. Agric.* **17**, 174—177.

Luthra, J. C. and Bedi, K. S. (1932). *Ind. Jour. Agric. Sci.* **2**, 499—515.

Sattar, A. (1933). *Annals App. Biology.* **20**, 612—632.

————. (1934). *Tran. Brit. Myco. Soc.* **18**, 276—301.

Trotter, A. (1918). *Rev. di Fatal. Veg.* **9**, 7.

PRACTICAL ADVANTAGES OF THE WEANING SYSTEM

BY

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No doubt to an outsider the weaning system seems to be a cruel system as the calf is separated at birth and the mother and the calf never have a chance to see each other. Before I started dairying and qualified myself in this line I always thought that the weaning system was inhuman and cruel and I was of the same opinion when I went for my dairy training to England in 1919 and throughout the course of my training in spite of all the lectures and literature we received on the advantages of the weaning system. After finishing my studies and taking my Diploma in Dairying I returned to India and started a dairy at Montgomery, Punjab, in 1922, equipped with up-to-date machinery, etc., which I had brought with me. The cows were of the Montgomery breed and I started milk recording, morning and evening, of all individual animals on up-to-date methods. I would like to explain my difficulties in consequence of the lack in India of pedigree herds and of effective legislation to prevent adulteration. This would however make a lengthy paper and would be going beyond the scope of my note on the weaning system.

With the ideas that I had against weaning and for the other reason that it is generally known that Indian cattle do not take easily to weaning and against all the disadvantages which are given I did not start weaning for full four years, when I came to the conclusion that either I should have to give up this profession or must adopt the weaning system if I wished to make any progress. I raised the strength of my herd, as will be seen from the following statement, and also introduced buffaloes.

(1) During the four years prior to my introducing the weaning system the milk yield remained very low.

(2) Some calves died and the cows went dry as they refused to give milk after the calves' death and had to be kept dry for a very long time. In one individual case the dry period was 550 days.

(3) All the calves have to be kept whether they were worth rearing or not till their mothers went dry which meant about a year and the useless ones had to be sold on an average of Rs. 5 after spending Rs. 56 which is the cost of rearing of each calf for the first year at this Farm. This means Rs. 51 dead loss per useless calf every year.

(4) As milking takes place at 4 in the morning and 4 in the evening and in winter months particularly morning milking is fairly early and in cold and dark nights sometimes calves drank milk of their mothers or the *gowala* had a good feed on the pretence that the calves escaped unnoticed and drank their mothers milk.

(5) Milk records checked by myself varied to such an extent that they almost looked fictitious; and with such a big variation the *gowala* and the milk recorder always had some excuse or other and had more chance of stealing milk.

(6) Calves were not regularly and effectively fed.

(7) The calves and milking herd had to be separately grazed and given exercise as otherwise the calves would always suck their mothers if they were taken together.

(8) The dry period was very long and irregular.

(9) Some cattle got into the habit of holding milk back.

(10) Calves were not given regular milk feed and maturity was prolonged.

(11) Unprofitable animals were not marked out early and got rid off.

Since the weaning system was started the following improvements have been made, as shown in the statement given below, and are entirely due to the adoption of the weaning system. As may be seen from the statement 98·3 per cent cows and 97·7 per cent buffaloes have been successfully weaned at all ages, from the 1st to the 5th calving.

(1) The milk yield went up from 976 lbs. to 3,170 lbs.

(2) The danger of cattle going dry in the event of calves dying was entirely removed as the calf being alive or dead meant nothing to the cow.

(3) All the useless calves are given away free to the farmers in the neighbourhood as soon as they start drinking milk freely from the bucket on the condition that one man from the Dairy staff goes round to see these calves twice a month and the calves which are not looked after properly are taken away and given to other farmers without paying any remuneration. The practice is continued for six months after which the calves are branded with hot iron, given a serial number and M as the mark of Montgomery Dairy on the right side and age brand on the left side. The result is that, all round the farm, our calves are seen working as bullocks —as a rule only male calves are given with the advantage that the farmer has an improved breed of calves and the Dairy effects saving of Rs. 5 on each calf which it used to spend on useless calves before weaning was introduced.

(4) There is no danger of the calf being let off in dark and cold nights, *gowalas* and staff have very little chance of stealing as the milk yields mostly tally with the previous records at the time of inspection or if there is decrease or increase it will be in the whole herd.

(5) Milk records are exact.

(6) The cattle are regularly and effectively fed and illness is at once noticed on account of sudden fall in milk yield.

(7) The whole herd including the calves as soon as they are fit to graze are let off together which means a great saving in labour and no chance of their sucking.

(8) The dry period is cut short and regular calving is maintained.

(9) Cows do not hold back their milk.

(10) Calves are regularly and systematically fed and reach the age of maturity much earlier than before. Before weaning was introduced the average age at first calving was 4 years 5 months. But when weaned they calved on an average at the age of 3 years and 8 months, a saving of 9 months.

(11) All unprofitable cattle are eliminated after every lactation and only good ones are kept and bred from, with the result that no cow or buffalo is kept on the Farm giving less than 3,500 and 4,000 lbs. in 300 days and this standard is being raised from 200 to 300 lbs. every year.

(12) Seventy-five per cent of cattle remain in milk. Weaning system is absolutely a necessity in a milking herd where pedigree records are kept because it will not be far wrong to say that no records are perfect without weaning.

(13) Pedigree stock always fetches higher price.

NOTE.—With weaning proper feeding is of course essential; one cannot be said to be perfect without the other.

Table showing the progress of weaned and unweaned animals at the Montgomery Dairy Farm is given below—

TABLE

Showing progress of the weaned and un-weaned herd of the Montgomery Dairy Farm, Montgomery, from 1922 to 1935.

Year	No. of animals	Description		Weaned or not	Weaning unsuccessful		Average yield per day		Average yield per lactation		Cattle rejected being unprofitable		Births		Calves given free		Fat per cent	
		Cows	Buffs.		Cows	Buffs.	Cows	Buffs.	Cows	Buffs.	Cows	Buffs.	Cows	Buffs.	Cows	Buffs.	Cows	Buffs.
							lbs.	lbs.	lbs.	lbs.								
1922-23 . . .	84	82	2	No	...	...	6.7	9.1	976	1200	1	...	32	1	...	...	4	6.6
1923-24 . . .	122	112	10	No	...	...	7.1	8.7	988	1317	4	...	54	15	...	...	4.2	6.5
1924-25 . . .	140	122	18	No	...	...	8.1	9.5	1170	1524	12	...	74	13	...	...	4.1	6.7
1925-26 . . .	152	131	21	No	..	...	8.4	10·1	1257	1791	22	...	79	15	...	...	4·0	6.9
1926-27 . . .	166	137	29	Yes	7	2	8·9	10.3	1826	2251	11	...	74	14	...	...	4.3	6.9
1927-28 . . .	157	128	29	Yes	5	2	10.4	10.9	2100	2640	11	1	86	12	...	...	4.2	6.8
1928-29 . . .	152	127	25	Yes	4	...	11.0	12.1	2727	2925	15	2	87	12	...	...	4.1	6.9
1929-30 . . .	140	114	26	Yes	2	...	11.3	12.9	2815	3100	17	1	98	14	...	...	4.3	7.1
1930-31 . . .	135	102	33	Yes	2	1	11.7	13.6	2912	3317	33	2	99	16	52	6	4.4	7.1
1931-32 . . .	154	119	35	Yes	1	1	9.7	11.1	2859	3000	4	2	97	30	41	14	4.2	6.7
1932-33 . . .	135	107	23	Yes	..	...	12.0	13.9	3009	3517	15	5	90	22	37	8	4.4	6.9
1933-34 . . .	135	107	28	Yes	...	...	12.2	14.1	3099	3700	24	2	89	24	48	12	4.3	7.1
1934-35 . .	136	109	27	Yes	1	.	13.5	14.9	3170	4040	11	4	88	20	46	11	4.5	7.1

NOTE.—Sudden fall in milk yield in 1931-32 was due to an outbreak of foot-and-mouth disease.

THE MOTH BORER (*ARGYRIA STICTICRASPIS* H.) OF SUGARCANE IN SOUTH INDIA

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Scientific work on sugarcane pests might be said to have started in South India when the Madras Government opened the agricultural station at Samalkota in the Godavery Delta in 1902 with the idea of investigating the red-rot—a disease that was prevalent then—and Dr. Barber, the then Government Botanist, was put in charge of the work. Since then other cane stations were added and studies were begun with the different aspects in regard to various local and foreign canes. At present the chief cane stations we have in South India are :—Anakapalle in Vizagapatam district, Palur in S. Arcot district, and the Imperial Cane Breeding Station at Coimbatore. In view of the rapid progress made in the study of canes and in view of the increasing areas under sugarcane all over India a study of the pests of cane has become very essential and none too early.

While the senior author had several opportunities of making a general study of the entomology of sugarcane in the various parts of the province since 1906, the junior author had the chance of studying the problem at some detail while he was stationed as entomological assistant at the Anakapalle station during the years 1930—32 and to do some work in connection with insecticidal trials at the Coimbatore Cane Station.

THE MAIN PEST

The one about which we are chiefly concerned and which causes damage to canes in South India is the cane borer *Argyria sticticraspis* Hmpsn. What *Diatraea saccharalis* Fabr. is to other sugarcane-growing countries such as Louisiana, British Guiana, Cuba, etc., so is *Argyria sticticraspis* H. to us. The life-history and habits of this borer are as follows.

The oval, thin, white eggs are laid in masses, partially overlapping one over the other resembling the "scales of a fish." Each egg is 0·7 to 1·0 mm. in length. In one instance 405 eggs were laid by a single moth and the average by a single female was found to work at 229 eggs. The egg-masses are generally laid on the

underside of the leaves. The egg period is about 3 to 4 days. The newly-hatched larvae scrape the leaves at the outset and do not enter the shoots from the top as is the case with *Scirpophaga*. While so scraping, when there is a waft, the hatchings hang by the silken threads or strands and are tossed hither and thither and come into contact with the bottom portion of the shoot. Here they feed at the outset on the tender sheaths by scraping and causing small holes, thus gradually making their way into the shoots. The entrance inside the shoot is made from outside. Around a single shoot four or five holes may be seen at different points. All these may be due to a single caterpillar or more. A single larva may enter a shoot, go on boring the inside, come out again and enter a fresh shoot. This is noticed especially in cases where tillers have been put forth in clusters of groups of 3, 4 or 5 as the case may be, in which case a single larva scrapes the outer sheaths alone in one tiller, enters another tiller and comes out again a third time, enters another fresh tiller and so on until at last when it becomes fully fed a cocoon is formed out of frass inside the shoot in which it pupates. After a period varying from 6 to 10 days the adult moth emerges and escapes out of the stem through one of the holes made by the larva. The longevity of the adult in the case of female has been found to vary from 8 to 12 days and 6 to 9 days in the case of the male when fed with molasses ; and in the case of a male it was found to live for 5 days when starved. The moths are dirty brown, characterised by the absence of any prominent markings. They shun the light and during day time they generally hide amidst cane trash, dried-up heaps and inside crevices in the soil and are active only during nights when they are attracted to light also to a certain extent.

Nature and extent of damage by borer

The caterpillars attack the shoots inside at the bottom and cause the central portion, "the spindle", to dry up and causing what is known as the "dead heart" which snaps. Ultimately the particular shoot dies. This is what actually happens in the case of young shoots. They attack also mature canes in which case the buds are also bored right through and tunnelling may be noted among the internodes, and these have been found to extend to about a foot in length even in certain cases and the diameter of the bore may be up to 5 mm. across. As a result of attack to canes it might be that a severe attack may bring about a low stand at the time of harvest. As a result of attack to mature canes by causing tunnelling, the canes may dry up resulting in the diminution of sucrose and purity being lowered ; and at the same time the canes might get hard and thus difficult for milling ; and there will also be reduction in yield.

Extent of damage.—It is this aspect of the problem that requires a detailed examination. Before getting into this study one has to take into consideration the following points, *viz.*, a definite number of setts are planted and out of this only a certain percentage germinate which constitute the primary shoots.

By the fourth week tillering commences and side shoots are put forth and this takes place till the time of first wrapping when superfluous tillers are removed —healthy as well as attacked—and only a definite number—those with good vigour—is retained ; and at the time of harvest we get only a certain number of canes. Of these the stand at the end decides the yield. Now to take a concrete example, take a variety J247 the germination of which is about 69 per cent.

Total buds planted	Germinated	Before wrapping shoots	After wrapping shoots	Tillers removed	At harvest time
6480	3943	14100	7791	6273	4842

Thus it can be seen that the stand at the end is more or less nearer those that actually germinated at the outset and at the time of first wrapping 45 per cent of the shoots were removed. Thus it can also be seen that the shoots produced in the interim have been found to be of no avail and there has been no appreciable reduction in yield.

The extent of damage in the case of sugarcane may be studied under the following heads :—

1. Effect of damage to young shoots in the early stages—from the time of germination up to the time of first wrapping—on the yield at the end.
2. Effect of damage to primary shoots in the early stages on the yield at the end.
3. Effect of damage to mature canes, *i.e.*, damage to internodes.

1. Effect of damage to young shoots in the early stages—from the time of germination up to the time of first wrapping, when superfluous tillers are removed—on the yield at the end.—Even at the outset, in considering this aspect of damage, it will be interesting to note how the ryot views the damage at this stage of the crop and this can well be stated in the words of the late Dr. Barber as follows : "The ryot views the matter with equanimity because he knows that the pest merely causes the lateral branches to be developed into larger numbers and he asserts that he gets a better stand of canes when there is an attack of the moth borer."

In the case of attack to young shoots the following are possible :—

(*a*) The plant itself will die ; (*b*) as a result of attack more shoots will be put forth ; (*c*) the attack happens to the primaries as well as to the secondaries ; (*d*) it may be that the attack may happen to the primaries even before the side shoots are put forth or after that ; (*e*) as a result of attack at various stages there will be shoots of varying ages ; (*f*) heavy output of shoots would also mean dissipation of food material in the soil.

In these circumstances it is incumbent on us to find exactly the damage done by the borer in the early stages on the yield. The best way of doing this will be to correlate the infestation in the early stages with the stand at the end and the consequent yield. To note the percentage of infestation during this period, counts were taken in the following manner.

The infestation commences only from the fifth week. Therefore weekly counts of "dead hearts" were taken plot by plot till the time of first wrapping; and no counts were taken afterwards in view of the removal of superfluous tillers and the infestation itself going down as the canes begin to mature. This period may vary from 3 to 6 months according as the time of planting. The percentage of infestation to be referred to hereinafter would mean the infestation during this period. We know the number of "dead hearts" got throughout this period. We know the number of healthy shoots at the time of first wrapping. Both these totalled together would give us the total output of shoots during this period. And the percentages are worked out in relation to this total number. Of course one point that needs mention here will be that there may be some dying for causes other than the borer and such shoots may not be many and these do not come in this, and even if these are taken into account we may not know whether these will get attacked or not or were attacked before.

When once a method has been evolved to work out the percentage of infestation, one can correlate the same with the yield at the end, which would give us the effect of borer attack.

The following statement would give us an idea as to the effect of borer infestation on the stand and yield results obtained in the case of certain experimental fields on the sugarcane station at Anakapalle during the season 1931-32.

Field No.	Experiment	Stand at the end			Variety	Per cent infestation
		3 links	4 links	5 links		
63	Spacing .	35944	33313	32466	J 247	60
		9361·1	9494·79	9345·83		
		Yield in pounds per acre.				

From the above it can be seen that the yield obtained is fairly more than the average of 5000 to 6000 pounds; and a 60 per cent all-round infestation has not been able to cause any appreciable reduction on the yield. This is the case of a field where there is uniform distribution of the pest.

In the case of another field the following results were obtained :—

Plot No.	B 208			MA 21		
	Per cent infestation	Stand	Weight of jaggery	Per cent infestation	Stand	Weight of jaggery
1	26·14	380	104·75	22·88	518	175·75
2	44·11	387	105·25	31·23	471	146·75
3	39·22	396	111·75	38·04	413	143·50
4	39·76	382	107·25	32·99	526	157·25
5	37·80	364	105·00	31·20	504	174·25
6	37·12	378	106·25	29·69	534	190·25

The above is the case of a field where there are two varieties B 208 and MA 21. The two show a similar range of infestation. The different plots show different degrees of infestation and it is easy to correlate the infestation with the yield. The infestation has been found to vary from about 26 to 37 per cent in the former and about 22 to 29·69 per cent in the latter. But the yield has been found to be more or less steady showing no variation according to the degree of infestation. This again shows that the yield has not been affected by the infestation in the early stages. The most glaring instance in the above is that there had been very little difference in yield, *viz.*, when the infestation is 26·14 per cent it is 104·75 lbs. and when the infestation is 44·11 per cent it is 105·25 lbs. in the case of B 208 ; and there had been very little difference in stand and the figures when carefully gone through will reveal that the whole thing is erratic.

Results of manurial trials will further confirm the above view points.

Serial No.	1 ton G. N. C.			15 cwt. G. N. C.			10 cwt. G. N. C.			8 cwt. G. N. C.		
	Per cent infestation	Stand	Weight of jaggery	Per cent infestation	Stand	Weight of jaggery	Per cent infestation	Stand	Weight of jaggery	Per cent infestation	Stand	Weight of jaggery
1												
2	31·62	899	220·75									
3	27·70	1056	254·25	37·98	948	236·50	36·37	1000	233·25	30·48	965	
4	43·54	947	254·50	44·05	889	252·50	51·45	810	211·00	41·63	982	

G. N. C. Ground-nut cake.

Even in the above case it is erratic and the infestations do not appear to govern the yield.

With reference to another manurial trial:

	F. Y. M.	G. N. C. W. I.		F. Y. M. Ammonium sulphate		
Serial No.	Per cent infestation	Stand	Weight of jaggery	Per cent infestation	Stand	Weight of jaggery
1	38·05	890	164·25	30·24	956	213·75
2	31·59	901	161·75	32·39	920	171·00
3	32·00	1113	205·25	32·65	883	180·75
4	27·37	995	182·25	27·01	967	198·00
5	27·92	952	186·50	31·84	888	186·75
6	26·61	969	174·00	24·87	908	193·25

F. Y. M. W. I.

Serial No.	Per cent infestation	Stand	Weight of jaggery
1	25·65	1000	191·25
2	24·40	978	180·75
3	23·12	986	173·75
4	25·16	968	177·25
5	25·57	898	167·75
6	21·21	990	190·00

From the above it can be seen that the infestation in the early stages may not affect the yield at the end. And this, one has to attribute to the fact that the crop is able to recoup very well during the period between the removal of superfluous tillers and the time of harvest.

2. *The effect of damage to primary shoots in the early stages on the final out-turn of the crop.*—During the season 1931-32 the experiment to note the effect of damage to primary shoots in the early stages, *i.e.*, from the time of planting down to the time of first wrapping on the yield and tonnage at the end, *i.e.*, at the time of harvest, was continued with two varieties B 201 and J 247. Two six-cent plots were taken in the case of B 208 and four such plots were taken in the case of J 247. The attacked and unattacked primary shoots were marked with pieces of cloth and stakes and the individual clumps were tied together—constituting attacked and unattacked clumps according as the respective primary shoot is attacked or not. Only 160 clumps of attacked and unattacked can be got from each of the six-cent plots; and in the case of J 247, in plot IV, only 120 clumps can be obtained from each. Forty clumps constituted a sample taken at random from the 160 clumps, thus constituting 4 samples in all.

The figures below represent the increase over the attacked :—

Variety	Number of canes	Weight of canes	Sucrose	Weight of jaggery
	Per cent	Per cent	Per cent	Per cent
B 208	− 4·48	10·27	—0·28	7·88
J 247	17·11	33·13	5·15	40·31

From the above figures it would appear that the general trend is in favour of the unattacked. This is what one finds after the averages are struck. If only we examine the figures closely, one could find variations from plot to plot. In the case of B 208 the results are erratic. In one plot the distribution of the pest is to a greater degree than in the next plot; and whereas in the case of J 247 the differences noticed between the attacked and the unattacked clumps were very marked and pronounced even to a judgment of the eye. In the case of the attacked the canes were very slender and delicate and thin at the point of breaking; whereas in the case of unattacked the canes were very thick and uniformly good comparatively and a uniform difference has been maintained between the attacked and unattacked in each of the plots. This pronounced difference is rather difficult to explain especially when we note the erratic nature in the case of B 208. It might probably be due to a predisposition in the case of the attacked to succumb to any adverse factor and consequently should have fared worse; whereas the unattacked should have withstood, coming up well as they were at the beginning. But the general stand of the crop in the field would appear to be poor. Another point

that might be of interest is that similar number of canes show greater weight in the case of unattacked than in the case of attacked.

In conclusion it might be said that the results are in favour of the unattacked; still it is rather unsafe to determine this effect of damage to young shoots on the yield because the crop remains, after the attack, for 8 to 9 months and the canes may recoup very well during this period and any effect felt cannot be correctly determined.

3. *Effect of damage to mature canes.*—In this case the damage happens to the internodes as a result of tunnelling, such canes are generally hard, devoid of juice, difficult to be milled, the purity of the juice and the quality of the jaggery being affected thereby.

Sometimes it might so happen that in certain cases the internodal buds will also be damaged, in which case the planting material will be affected. Of course the damage is not much in this direction.

Damage has been noted to be serious in the case of seedlings raised from seeds at the Cane Breeding Station, Coimbatore, especially during the season 1927, when 5000 to 6000 seedlings were damaged. Here, in this case, the seedlings are too young and borers were found to attack the tillers as well.

Again, in the wake of borer attack, other insects might gain entry and cause further havoc; and, it is possible, fungus diseases may also gain entry.

Incidence of the pest

This study may be styled as an ecological study of the pest. By an ecological study is meant a study of the incidence of the pest in relation to environment, such as the responses due to meteorological conditions, irrigations meted out, spacings given, time of planting, nature of seed material used, ability of a variety to put forth large number of shoots and its relation to the degree of incidence, cultural operations such as hoeings or ploughings or *guntaka* workings given and if so their effect, direct or indirect, on the pest. A study in this direction would give a clue as to the reason for any high degree of incidence noted anywhere and also gives an idea as to the factor or factors that govern such incidence.

(*a*) *Rainfall and its effect.*—The average rainfall in the Vizagapatam tract is about 40 inches and the same during the year 1931-32 was 43·5 inches. And in this particular season during which counts of infestation were taken, it would seem that the rainfall during the hot weather which comprises the months of March, April and May was far below the averages, *viz.*, 3½ inches, the average being 6·75 inches for 5 years. If we classify the season into hot weather—March, April and May; South-West monsoon—June, July, August and September, and the North-East monsoon—October, November, December and January, then the planting

is done during the hot months and the wrapping and proppings during the South-West monsoon by which time the superfluous tillers are removed and the canes begin to develop. The distribution of rainfall for the year is as follows :—

	Inches
Hot months	3·48
South-West monsoon	18·64
North-East monsoon	21·40

The planting time generally comes during the hot months and naturally the plantings on the station fall within this period and it can be seen from the following plantings that the incidence is very high during the early plantings :—

Field No.	Treatment	Infestation	Remarks
		Per cent	
63	Spacing experiment	60·4	Planted during February
53	Irrigation experiment	55·8	
	Manurial G. N. C. series . .	38·82	Planted during March
	Manurial F. Y. M. series . .	28·20	
	MA 21 and B 208 comparison .	36·10	
	Varieties Class I	20·32	Planted during April
	Varieties Class II	21·44	
	Proppings and wrappings . .	17·44	

From the above it is clear that as the crop synchronises with the early rains the infestation goes down and it follows that absence of rains does exert a favourable influence on the degree of incidence of the pest.

(*b*) *The effect of drought.*—When fields No. 63 and 53—spacing and irrigation experiments respectively—are taken into consideration, then irrigation or no irrigation does not appear to cause any differentiation in the degree of infestation. These two have been taken up for comparison because both happen to be early plantings, planted by about the middle of February ; and similar number of counts

were also taken in both the cases; and the former received irrigations and the latter did not. The degree of infestation is higher in both the cases, *viz.*, about 60 per cent and 55 per cent respectively, but when we take into account the irrigation experiment—late planted, *viz.*, Field No. 54—planted in April—it shows 52 per cent infestation and if this is compared with other plantings done in April which received irrigations and showed a lower degree of infestation than even those planted in March, it would seem as if drought is responsible for this heavy degree of incidence of the pest. Thus we see early-planted showing a similar degree of infestation both in the irrigated and unirrigated; and the late-planted showing higher degree in the unirrigated and less in the irrigated. In the former it can be explained that the two plantings come under the hot weather characterised by the absence of rains; whereas in the latter, in spite of rains, the late-planted irrigation experiment does not get irrigation and this comes to absence of water-supply which comes under drought. Thus the two can be explained as due to drought conditions.

(*c*) *The nature of the seed material used and pest incidence*.—In the case of another field 10-A.—Wrapping experiment with Co. 213—the one point that stands prominent is that in the case of the short crop seed, irrespective of the wrappings, the percentage of infestation is consistently higher in all the three treatments than in the case of the mature seed as the figures below show :—

	Per cent		Per cent
Propped and unwrapped short crop seed . . .	22·65	Propped and unwrapped mature seed	16·82
Propped and half-wrapped short crop seed . .	22·72	Propped and half wrapped mature seed . . .	12·63
Wrapped and propped short crop seed . . .	17·80	Wrapped and propped mature seed	12·03

Thus it is further confirmed that in the case of Field No. 23—Class II—canes B 208 (short crop seed) have shown a percentage of 24·48 per cent as against 16·57 per cent (local seed).

(*d*) *The effect of the different manurial treatments on the degree of incidence of the pest.*—There are two manurial experiment fields — one goundnut cake (G. N. C.) series and the other farmyard manure (F. Y. M.) series. The results of these two experiments have shown that the variation in the degree of infestation for a particular treatment among the different repetitions is more or less to the same extent in the case of the different treatments; and if at all there is any difference between any two treatments it might be due to any factor and it may not be possible

to say to what factor unless further observations are made over the same series. The variations may be seen in the following cases :—

10000 lb. F. Y. M. 2000 lb. W. I. 640 lb. G. N. C. I	10000 lb. F. Y. M. 2000 lb. W. I. 260 lb. Ammonium sulphate II	27665 lb. F. Y. M. 2000 lb. W. I. III
Per cent	Per cent	Per cent
38·05	30·24	25·65
31·59	32·39	24·40
32·00	27·01	23·12
27·37	32·63	25·16
26·92	31·84	21·21
26·61	24·87	25·57
30·59	29·83	24·19

From the above it can be seen that in the case of I and II there is very little difference as the averages will show and in the case of III the infestation is comparatively low and this is so with very little range of variation among the different repetitions. Now comes the difficulty whether this is due to the particular treatment and if so this requires to be further confirmed.

(e) *Time of planting and the degree of incidence.*—Fields planted by about the month of February, *viz.*, the early-planted ones, showed a very high degree of infestation rising up to even 60 per cent; then come the March plantings which show infestation up to 35 per cent; and lastly come the April plantings where the infestation is as low as 11·92 per cent—barring the irrigation experiment—late planted.

(f) *The effect of spacing on the incidence.*—The degree of infestation in the two spacing experiments—early and late—shows that the attack has been more or less

distributed to an equal degree among all the spacings and the following figures represent the infestations :—

Field	3 links	4 links	5 links
	Per cent	Per cent	Per cent
Early-planted	60·75	60·4	60·06
Late-planted	29·00	27·65	29·68

From the above figures it is clear that light and space do not appear to have exerted any influence at all on the degree of incidence of the pest.

(*g*) *The effect of* guntaka *working on the degree of incidence.*—There were reports to the effect that *guntaka* workings have minimised the infestations a good deal. On the Anakapalli station *guntakas*, it would appear, were worked in all the fields but the counts of infestation showed no relationship with this. On the other hand in certain cases where *guntakas* were worked, the infestation was as high as 60 per cent.

(*h*) *Topographical relation of the fields and the incidence.*—(To study whether the degree of incidence in the different portions of the same field is due to any differential treatments or due to chance egg-layings in the field by the insects.) Plans of field were drawn up and the percentages of attack were marked out plot by plot in the case of the different fields, to study this variation. A run at these plans shows that the degree of incidence does not appear to vary according as the treatments—whether manurial or otherwise—meted out but in a very erratic fashion irrespective of the treatments, thus making it difficult to say whether the variations noted are due to any one or several other extraneous factors.

(*i*) *Number of shoots put forth and its relation to the degree of incidence.*—The point under study in this connection is this, *viz.*, whether one can minimise the degree of borer attack by having a variety which would be able to put forth large number of shoots. In the course of studies on borer incidence, it was thought that the degree of borer incidence is greatly influenced by the number of shoots put forth. This was amply borne out in the case of Fields No. 53 and 54—Irrigation experiments, early and late plantings respectively—where a more or less equal degree of infestation among the four varieties has shown varying degrees of effect on the number of canes present immediately before and after wrapping. And this variation among the four varieties, *viz.*, J 247, Max 10, MA 21 and Co. 213, was found mainly due to the variation in the degree of the total output of shoots among these varieties ; and in the case of a variety like Co. 213 even a higher degree of infestation does not appear to have caused much reduction in the number of canes present

immediately before and after wrapping, whereas a similar degree of infestation caused a good deal of reduction in the case of the other varieties. In the case of these two fields there was white ant attack also and in spite of this Co. 213 has given large number of shoots more than half of what was obtained in the case of the other two varieties with regard to the before-wrapping shoots. It is known that Co. 213 is a good tillerer. Therefore it was thought that the degree of tillering decides the degree of borer infestation. But in the case of a variety like MA 21, though it tillers to the extent Co. 213 does, when one enters a field of MA 21, the field will be gappy and this has been found due to poor germination. Therefore it is that in order to have a variety which can put forth a large number of shoots, that particular variety should have good tillering capacity and good powers of germination. It might be that a variety with a low percentage of germination may show good capacity to tiller as is the case with MA 21. It might be that a variety with a high percentage of germination may show also an equally good tillering capacity as is the case with Co. 213. It might be that a variety with good percentage of germination may have a poor capacity to tiller as is the case with P. O. J 2878 and to a degree in the case of J 247. And it might also be possible that a variety with poor germination may show poor tillering capacity. Thus it can be seen that either good percentage of germination or good capacity to tiller by itself may not be a sufficient character for a variety to be commendable. But a combination of both may prove to be highly advantageous in inducing that variety to put forth a large number of shoots. A variety which is capable of putting forth a large number of shoots would appear to have the following points to its credit :—

(*i*) If it were to show an equal degree of infestation along with other varieties with which it is compared, this will always show a larger number of shoots, before or after wrapping, than in the case of the other varieties.

(*ii*) If in a field the infestation is equally distributed among the several varieties, then the variety which shows a large number of shoots or is capable of putting forth a large number of shoots will naturally show a lower degree of infestation than in the others.

(*iii*) If a variety is capable of putting forth a large number of shoots then it might be possible to get the required number of canes at the time of harvest even after making due allowance for contingencies such as deaths of shoots in the early stages and deaths due to damage to internodes later and the consequent entry of fungus and other diseases, etc.

All treatments that one might give appear to centre on this aspect of inducing the varieties to put forth a large number of shoots, *i.e.*, spacing, manurial treatments, drought, etc.

(*j*) *Varietal susceptibility.*—This aspect of the problem requires a thorough and detailed study. In connection with this the following terms have to be clearly understood, *viz.*, resistance, susceptibility, immunity and tolerance. **Resistance** would mean the ability to check the progress of attack ; **susceptibility** would mean succumbing to the attack ; **immunity** would mean absolute freedom from attack and its ability to ward it off by character inherent to it ; and **tolerance** is the power to bear the brunt of the attack in spite of the damage being done, not succumbing to the attack. Susceptibility to or immunity from an attack may mainly be due to certain inherent characters of a physiological or morphological nature found in the varieties themselves. Resistance to attack may be classified under two heads, *viz.*, direct and indirect. Direct resistance may be defined as that by which variety or varieties are capable of resisting the disease on account of certain characters inherent or ingrained in the gene itself; and indirect resistance may be due to the effect of certain environmental factors on the varieties themselves. Varieties with least degree of susceptibility, amidst natural and field conditions, may be styled as resistant. It might be possible that varieties showing resistance under field conditions may become susceptible when inoculated ; varieties supposed to be resistant to a high degree may show symptoms of susceptibility and less resistant ones showing pronounced symptoms ; plants might get attacked at the beginning and recover afterwards when the crop gets an advanced stage. Resistance may after all prove to be relative in the case of any variety depending upon conditions favourable for the incidence of the pest.

From those it can be seen that to talk of varietal susceptibility it would be unsafe unless all aspects of it are taken into account.

Varietal susceptibility in the case of canes may be studied by taking into account the two irrigation experiments—early and late—where the percentage of infestation among the four varieties is as follows :—

Variety	Early	Late
	Per cent	Per cent
J 247	59·9	54·98
Mex 10	58·4	55·23
MA 21	53·1	51·66
Co. 213	51·8	46·97

From the above figures it can be seen that there has been little difference in the degree of attack in the case of the two fields and so also among the different varieties. In the case of the two fields there appears to be an even distribution of the pest inspite of the four different varieties.

Coming to Fields No. 25 and 23, percentage of infestation among the varieties is as follows :—

Field No. 25.

Variety	Per cent	Variety	Per cent
J 247 . . .	24·03	Co. 290 . . .	18·26
Co. 213 . .	27·72	Co. 312 . . .	10·63
Co. 243 . . .	22·42	Co. 313 . . .	16·17
Co. 281 . . .	20·33	MA 21 . . .	23·01

The average works out at 20·32 per cent.

Field No. 23, Class II.

Variety	Per cent	Variety	Per cent
J 247 . . .	21·20	H. M. 544 . .	23·23
D 131 . . .	27·87	P. O. J. 2878 . .	22·93
B 208 . . . (Short crop).	24·28	Max. 10 . . .	19·06
		MA 21 . . .	28·04
H. M. 320 . .	22·10	Co. 213 . . .	16·03
B 208 . . . (Local seed).	16·57	Co. 290 . .	10·10

The average for the field works out at 21·04 per cent.

From the above it can be seen that the degree of attack may be said to be almost equal in the two fields. Herein also it is difficult to say whether there has been varietal resistance. For instance, in the case of varieties Co. 213 and Co. 290 it is 27·72 per cent and 18·26 per cent respectively in the case of Field No. 25 ; whereas it is 16·03 per cent and 10·1 per cent respectively for the same two varieties in Field No. 23 ; and one finds variation in the degree of attack in spite of the fact that there had been equal distribution of the pest in the two fields, among these varieties. Any variation in the degree of attack might be due to several factors. The so-called resistance that one finds might be dependent upon mechanical factors or otherwise. It is not definitely known in these cases whether there had been direct resistance to attack or the resistance due to characters associated with growth such as hardness or thickness of the cuticle, etc., or other similar morphological characters or to a sporadic or endemic nature of the borer itself. Therefore it may not be safe to conclude on these figures the response which the different varieties of canes make toward the incidence of borer attack.

In Tucuman, in view of the high degree of infestation noted among the native canes, they were replaced by the Java P. O. J. varieties. There was a phenomenal diminution in borer infestation. This was attributed to the resistance exhibited by P. O. J. canes and it was even reported: " .... with the general planting of the Java canes the moth borer has ceased to be a problem." In the words of Rosenfeld this difference in the degree of infestation between the native and the P. O. J. canes is due to "The increased fibre content of the rind and internodes makes penetration into the inner tissues of the cane by the moth borer a very more difficult matter than in such cases as Rayada, etc." Then came Holloway and Haley with their explanation, *viz.*, " .... it seemed that if the borer had ceased to be a pest it was not due so much to any resistance of the new varieties themselves as to another cause. The new varieties have given a number of "stubble" in Argentina as against one or two stubble crops of the old varieties. This means that less and less cane is planted and more and more springs up year after year from the stubble. Now it has been found that a dangerous source of borer infestation is in the planted stalks and the issuing adults making their way through the slight covering of soil, ready to oviposit on the plants of the grass family. Thus the less canes there were planted, the fewer borers were planted in the stalks, and as more and more of the long stubbling Java varieties were planted the numbers of hibernating larvæ were progressively reduced."

The above statement of Holloway and Haley is misleading and incorrect according to others, due to the fact that there had been a decided increase in the degree of infestation among the P. O. J. canes and secondly "that the extraordinary and sudden diminution in *Diatræa* infestation in the Tucuman cane fields first became evident in 1919, the year following the wholesale replanting of the fields with P. O. J. canes, when, according to Messrs. Holloway and Haley, there should have been an unprecedented increase in the amount of *Diatræa* due to the abnormally large amount of seed cane containing borers which had been planted the previous year. Further, it is rather difficult to comprehend how the effects upon borer infestation of the long stubbling feature of new varieties could possibly make itself felt while the majority of the fields were plants and first ratoons".

Then it became evident "that the notable reduction in borer infestation in Tucuman was due primarily to the effects of the abnormally severe winters which occurred at the time when the varietal change took place".

Therefore, anything in the nature of resistance should not be taken at its value but one should get into the factor or factors that are responsible for resistance.

Conditions favourable for the breeding of the pest

As far as agricultural practices are concerned: (*i*) there is no close period or anything like off-season characterised by the absence of crop, (*ii*) while the harvest is going on plantings will be done and, (*iii*) at the time of first wrapping superfluous

tillers, which include attacked also, are removed, and thrown into the manure pit.

Natural enemies

It is possible that almost all the parasites so far noted on moth borers on *cholam* and maize in addition to those noted on borers of cane are also enemies of the cane borers. The chief egg parasites of the cane borer are the minute Chalcid *Trichogramma minutum* Riley and the Scelionid *Phanurus beneficiens* Zehnt. These are also found parasitic on the eggs of *Scirpophaga* and the paddy stem borer *Schoenobius*. The larval parasites so far noted are *Stenobracon nicevillei*, B. No detailed studies have however been made as to the bionomics or the economic possibilities of these.

Control measures

(*i*) Several measures such as hand-picking of egg-masses, cutting out of 'dead hearts', setting up light traps and trash traps, burning of trash, etc., have been suggested by entomologists all over the world. But so far as we are concerned, no measures have been tried to test their comparative effectiveness on the degree of infestation; and consequently all these aspects require a detailed study before anything definite may be said on any or all of these methods. Trash traps were tried at Anakapalli and the catches were not commensurate with the trouble taken in examining the trash; but on the other hand, the trash disclosed a number of snakes.

(*ii*) Biological control.—Much work has been done in other cane-growing countries of the world such as Louisiana, British Guiana, etc., especially in connection with the egg-parasite *Trichogramma minutum* Riley; and a good deal of technique has been evolved for the successful breeding of these parasites; and in this connection the names of Wolcott from Porto Rico, Spencer and Hinds from Louisiana and Flanders from California are worthy of note, especially the latter. Even here the consensus of opinion is not favourable and there are even warnings from certain quarters not to be carried away by this fad; and it may be well here to quote what Harry H. Smith has to say on this: " We cannot definitely say at the present time that the mass-breeding and distribution of *Trichogramma* is useless But, on the other hand, it must be admitted that none of the field experiments carried on up to the present with this parasite has given thoroughly satisfactory results. It would, therefore, be unwise to launch out on a large scale programme of *Trichogramma* work until the projects under way at present in various parts of the world have been carried on a little longer ".

Biological control is successful in Hawaii, but is not so in the West Indies. Therefore we cannot take it as a maxim that whatever is successful in other parts of the world will also prove successful in India. So far as we in South India are concerned, some work with the egg-parasite *Trichogramma* which is a cosmopolitan

insect and which many workers in different parts of the world are trying to utilise against the cane borers, as stated above, appears to be going on in Mysore and it is our idea also to try the same.

Therefore, before we attempt at a control in this direction it is incumbent on us to make a parasite survey along the following lines, *viz.*, the parasites that exist in our own country, their bionomics, their distribution, degree of incidence, seasonal abundance, the degree to which they are effective in checking the pest, and lastly to find out whether we have to supplement these with those from other countries.

(*iii*) Insecticidal trials.—During the seasons 1927 and 1928 insecticidal trials were conducted at the Cane-Breeding Station, Coimbatore. The following insecticides, *viz.*, Paris green and lime, sodium fluosilicate by itself, the same diluted with lime, lead arsenate powder, Levosol fluosilicate, paradichlorobenzene and Seekay were used.

And the results have shown that one cannot rely on insecticidal trials for borers, in view of the costliness of the insecticides themselves, the difficulty of application, the frequency with which they have to be applied, the injurious effects on the leave, and shoots when not properly diluted with lime or otherwise, especially when there are rains after dusting, the non-adhering properties of the dust in dry condition and last but not least the habit of the borer itself which lives and causes damage from inside the stems. On all these counts, insecticides are much limited in their scope.

Conclusion

In conclusion it has to be said that much work yet remains to be done, especially in connection with a study of its natural enemies and the possibilities of utilising these against the borers ; and much remains to be done in connection with control measures, especially comparing the effectiveness of the different types of control measures on the degree of infestation, which is the most important part of the work which would give us a working knowledge to apply these measures with a certain amount of confidence.

This paper does not profess to contain all about the cane borer ; but on the other hand, the object of the paper is to chiefly stress upon certain aspects of the borer problem such as the nature and extent of damage and the various factors that govern the degree of incidence, and to bring home that much work yet remains to be done, on lines similar to those conducted in other cane-growing areas of the world, in more intense and thorough fashion.

The writers wish to express their thanks to Mr. A. C. Edmonds, the then Deputy Director of Agriculture, I Circle, for affording facilities for the study of borer incidence on the Agricultural Station at Anakapalli, during 1930-32.

REFERENCES

Fletcher, T. B. and Ghosh, C. C. 1919. *Proc. Third Entl. Meeting, Pusa.*

Inter. Sugar Journal, XXX, No. 351, pp. 139-145, 1928.

Patrudu, S. and Ramiah, B. (1931-32). *Ann. Rept. Agrl. Res. Station, Anakapalli.* 1931-32.

Ramakrishna Ayyar, T. V. (1933). *Madras Agricultural Journal*, **21**, 421, 1933.

THE CODLING MOTH IN INDIA

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It is of interest to record the occurrence in India of the codling moth (*Laspeyresia pomonella* Linn), a very notorious pest of apples, pears, etc., in America, Australia and other important fruit-growing areas of the world. In U. S. A. alone where in addition to apples and pears, prunes, walnuts, quince, etc., are also attacked, the damage caused by this pest runs up to 2 to 3 million sterling per annum. The damage is done by the larva of this moth. Except for a doubtful record of this insect in Dras Ladakh (Kashmir) some years ago, this species has not been reported to occur in any part of the Indian Empire. But as a result of investigations carried out by one of my assistants in the environs of Quetta during the last summer it has been found that this pest, along with another pest (*Spilonota ocellana*) which does similar damage, infests several fruits in that area. The identification of the species has been confirmed by the Imperial Institute of Entomology, London.

A brief account of the insect and the nature of its damage is given below, so that fruit-growers in various parts of India may be able to recognize the pest if it appears in their orchards. The writer will be glad to receive reports, preferably accompanied by actual specimens, of the occurrence of this species in any part of India, so that the extent of distribution and economic status of the pest in this country may be determined.

The adult moths appear in orchards in spring or early summer when the apple trees are in flower. The moth (Plate XXXIII, fig. 1) is about 1/3 in. long and 2/3 in. across the wings when fully expanded. The fore-wings are brownish grey, with a characteristic copper-coloured patch near their apices. The moth lays eggs usually one, occasionally two or three in number on leaves, twigs and outsides of the flowers. The eggs are small, oval, very much flattened, resembling tiny, shining discs. The newly hatched larva is dirty white in colour, with a brown or dark brown head. It is very active. It generally enters the setting fruit through the "eye" or the calyx cup and gradually gnaws its way inside the fruit till it reaches the core where it eats up the pips and the neighbouring soft parts of the fruit. The "wormy" or the infested fruits become shrivelled up and reduced in size and with even moderately strong wind are likely to drop off the tree (Plate XXXIV). After feeding for three to four weeks within the fruit the larva becomes full-grown (Plate XXXIII, fig. 2) when it measures from $\frac{1}{2}$ to $\frac{3}{4}$ in. in

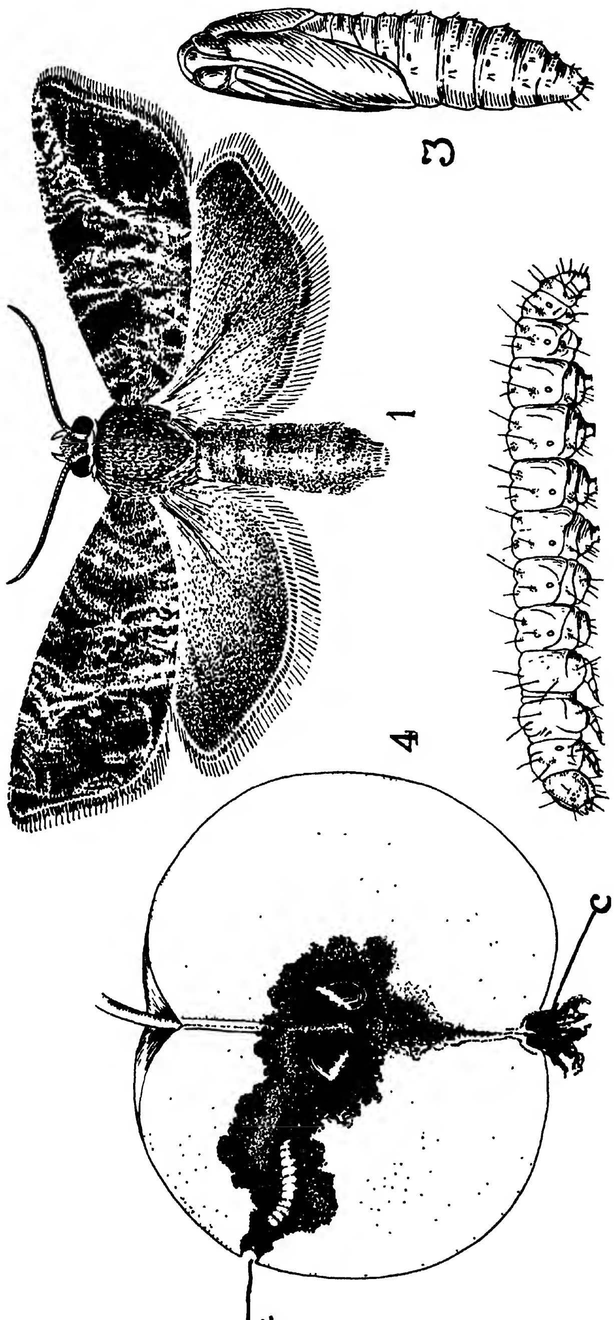

Fig. 1. The Codling moth $\times$ 6.
,, 2 The full-grown larva of the same $\times$ 6.
,, 3. The pupa of the same $\times$ 6.
,, 4. Section of an apple showing the damage done by the larva ; ***c***, calyx cup through which the young larva enters the fruit ; ***ex***, the hole through which the mature larva after doing the damage leaves the fruit.

Apple and pear fruits damaged by the larvae of the Codling moth.

Note the shrivelled appearance of the fruit and the exhit holes in their sides through which the larvae have gone out after doing the damage.

length and has a pinkish colour especially on its ventral side. It then starts eating its way out through the side of the fruit (Plate XXXIII, fig. 4) which may still be on the tree or may have dropped to the ground. The larva after leaving the fruit crawls under a suitable shelter, such as, crevices of bark, folds of dead leaves, corners of broken packing cases and other rubbish where it spins a silken cocoon and passes the winter therein. At the approach of the following warm weather it pupates (Plate XXXIII, fig. 3), and in due course emerges as adult moth and repeats the history outlined above. Sometimes the larva before entering the winter sleep may pass through another generation and thus there may be two generations in the year. The moth themselves do not eat anything except liquid things like the juice of fermented apple. They fly about at dusk and spend the day hiding under dead leaves, bark, etc.

The methods of control which can be usefully adopted against this pest may also be briefly described here.

"Prevention is better than cure" is very true in the case of insect pests. From the foregoing brief account of the life-history of the codling moth it will be noticed that its larvae pass winter in the crevices of dead bark, under dry leaves, old packing cases and other rubbish lying about in orchards. If all those shelters are removed and "wormy" apples destroyed whenever seen, the chances of the following crop getting infested will certainly be very much reduced. The soil round and below the trees should also be examined for the hibernating larvae which should be destroyed. Of course all the fruit-growers in a tract should take such measures simultaneously otherwise the pest will easily travel from the clear orchards to the unclean ones. Sometimes these measures of cleanliness are not enough to keep the pest down and the larvae have to be killed directly by various sprays. In winter when there is no fear of injuring tender foliage and flowers the trees can be cleaned with tar-distillate and other oily washes which besides killing some of the hibernating larvae reduce the number of cracks and crevices in which they can spin their cocoons. In summer a spray consisting of lead arsenate (1 lb. in 50 gallons of water) should be applied soon after the petals have just fallen off and before the calyx cups have closed so that some poison may get deposited in these cups, thus ensuring the death of the young larvae, which as described above, generally enter the setting fruit by this way. It will be readily recognised that this is the most important and effective measure. This spray is repeated 3 or 4 times at an interval of 12 to 15 days during the summer to kill the larvae hatching out later or those of the second generation if there is any. Such larvae often enter the fruit from the side, especially if it is bruised or soft due to contact with neighbouring fruit. It may be added that lead arsenate is poisonous to man and domestic animals and must be used with care. The writer will be glad to give further information about the preparation and use of the insecticides. A detailed article on this pest will be soon submitted for publication in *The Indian Journal of Agricultural Science.*

SELECTED ARTICLES

THE INDIAN SUGAR INDUSTRY *

BY

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The rapid increase in the Indian sugar production, since the grant of fiscal protection was decided upon in 1931, has been an event of sufficient magnitude to attract comment throughout the world. In 1928, when Sir James MacKenna addressed the Society on the future of the Indian sugar industry, he pointed out that of 3,076,000 acres under sugarcane in India, modern sugar factories only absorbed the produce of 80,000 acres. In 1930, when the question of fiscal protection for the sugar industry was referred to the Tariff Board, the position was much the same. The area under cane in 1929-30 was 2,677,000 acres; from this was produced 21,150 tons of sugar refined from *gur*, 89,768 tons of sugar produced direct from cane by modern factories, and some 200,000 tons of sugar manufactured by the indigenous open-pan or *khandsari* process, so that, allowing for setts for planting and cane for chewing, 1,837,000 tons of *gur* were produced for consumption as such.

For the sugar-crushing season 1934-35 it is estimated that the area under cane is 3,471,000 acres and the gross production in terms of *gur* 5,085,000 tons; production of sugar refined from *gur* will amount to 40,000 tons; sugar manufactured direct from cane to 580,000 tons; *khandsari* sugar to 175,000 tons; and *gur* for direct consumption to three-and-a-half million tons. By 1935-36 it is estimated that the production of sugar in modern factories will have reached 807,000 tons, and that India will be approximately self-supporting. The number of modern factories crushing cane in 1928-29 was 24, in 1930-31 it was 29, for the season 1934-35 it is 142.

When the Tariff Board made its recommendation, India still occupied the anomalous position of being at once the world's second largest grower of cane and one of the greatest importers of manufactured sugar, and outside India there were few who seriously believed that there would be any radical change. The Indian sugar industry had long suffered from the handicaps of low yields, poor-quality

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cane, small scattered patches of cane cultivation, and a land tenure system unfavourable to the establishment of compact sugar estates. The greater part of the sugarcane area lay in sub-tropical India with the very definite climatic limitation of a short growing season preceded by intense hot dry weather and terminated by a distinct winter season. These difficulties might well have seemed insurmountable, but they have yielded to research and experiment, and in actual fact the grant of fiscal protection was simply the culmination of a long period of sustained effort. It is as well that this should be understood, for there has been some ill-informed criticism of what has been termed a hasty experiment in protection, though even a cursory study of the Tariff Board's report shows that such was not the case and that the fundamental improvements necessary to the establishment of an efficient industry had already been secured. It is doubtless true that the virtual disappearance of India as an importer added to the difficulties of the sugar-exporting countries at a time when some of them were taking special measures to deal with the situation which had arisen from world over-production of sugar. But it must not be forgotten that the development and maintenance of her sugar industry is every whit as important to Indian agriculture as is the encouragement of sugar-beet cultivation in Europe. The State aid given to the Indian sugar industry is expressly designed to enable the large home market to be supplied with home-grown sugar, but no kind of incentive has been given to the creation of an uneconomic export trade. Moreover, as will be seen from what follows, the costs of production in India, though high compared to those in the great cane-sugar exporting countries, already compare favourably with those of some other sugar-producing countries. With these introductory remarks on the present position of the sugar industry, I will turn to the steps by which it has been reached.

The antiquity of the Indian sugar industry is a matter of common knowledge. There are many reasons for believing that India was the original home of the sugarcane, and it is fairly certain that crystallised sugar, as distinct from *gur* or *jaggery*, was made and used in India in very early times. Certainly, both a fine-grained white sugar and sugar-candy were being exported from Surat early in the seventeenth century and from Calcutta in 1659, and we know that Dutch traders shipped Bengal sugar from Masulipatam in 1636. To come to more modern times, the report of the Select Committee of the House of Commons on Sugar and Coffee Planting, published in 1848, records the fact that in 1835-36 India exported to England 7,184 tons of sugar, 26,913 tons in 1839-40, and an average of 59,373 tons during the period 1839 to 1847. It was stated that, at that time, India supplied about one-quarter of England's total sugar requirements. This trade was partly made up of the best quality "Benares" sugar, a whitish sugar made by the indigenous process, partly of "Muscovado" sugar, made by several companies and European planters, and partly of sugar refined from *gur* or *jaggery* in European-owned factories using modern machinery. Benares sugar was made largely for

internal consumption, and was only obtainable for export if prices were favourable. Muscovado was manufactured from cane on West Indian lines by planters; indeed, the inception of the sugar industry in North Bihar appears to have been due to a recognition of the need for rotation crops for indigo and to an appreciation of the inadvisability of complete dependence on that crop. At or about the time when the Select Committee on Sugar and Coffee Planting reported, there were sugar factories with such familiar names as Motihari, Suraha, Bara-chakia, Belsund, Gorakhpur, Rosa, and Padrauna. Unfortunately for both the Indian and West Indian sugar industries the recommendations of the Committee went unheeded. The preferential duties were abolished in 1851; neither country was able to compete with slave-grown sugar, and the Indian trade collapsed. When next the question of developing the Indian sugar industry arose, it was no longer a question of reviving an export trade, but of meeting a greatly enlarged internal demand.

This may be a convenient stage at which to digress for a moment in order to explain the term *gur* or *gul*, with its South Indian synonym *jaggery*, which will occur frequently throughout the lecture, and to give a brief acount of the indigenous Indian methods of converting sugarcane into edible products. I trust that I shall be forgiven if I repeat what must be very familiar to many members of the Society.

From time immemorial, the greater part of the sweet stuff used in India has taken the form of *gur* or *jaggery*, a kind of concrete sugar containing practically the whole of the molasses. There is no exact English equivalent for *gur*, and the term "raw sugar" which is used in Indian statistics and official publications is somewhat misleading as, throughout the sugar world generally, the term "raw sugar" connotes a product used by refineries and containing from 94 to 99 per cent of sucrose. *Gur*, on the other hand, is a product meant for direct consumption and contains anything from 60 to 85 per cent of sucrose; it is most nearly described as hard-boiled *masse-cuites*. This is the form in which some three-and-a-half million tons are now consumed annually. In colour, purity, hardness and flavour it varies greatly from tract to tract but, with relatively unimportant exceptions, it is not a raw refining sugar, but a final product ready for domestic consumption. *Gur* is still made in most sugarcane-growing villages and by the simplest processes. Modern two-roller and three-roller iron mills, and to a limited extent larger three-roller and five-roller mills which are driven by oil engines, have replaced the earlier pestle-and-mortar type of mill made of stone or wood and quite appreciable improvements have also been made in the furnaces and pans. But in essentials the process is much the same as it was a hundred years ago, the fresh cane juice being boiled down to solidifying point in an open pan. A certain amount of clarification takes place during this process, and multiple pans are common in some tracts where high-class *gur* is made. Naturally the characteristics and composition of *gur* vary widely from district to district and place to place.

The *khandsari* sugar industry has also persisted in some parts of the country but its stronghold is no longer Benares, as in 1834, but in the Rohilkhand Division of the United Provinces; it is estimated that some 175,000 tons* of sugar per annum are being manufactured by this method this year. The *bel*, as it is called, in which the juice is boiled, is a cascade of open pans, heated by a furnace which burns the megass from the cane and a good deal of wood or other fuel as well. Clarification takes place in the upper pans, hand-skimming of the scum, which contains all the protein matters of the juice, being continuous. Various plant juices and soda are used to assist defecation, but lime is not generally used, as a light-coloured syrup is essential. In the final pan the syrup is concentrated to crystallising point and the hot *masse-cuites* run into earthenware coolers which are agitated until crystallisation sets in. One radical change has taken place in this process during the present century in that centrifugal machines have replaced the older method of molasses separation by drainage followed by decolorisation with the water-weed *siwar*. Other improvements will be mentioned later. The resulting sugar—*khand*—differs from "Muscovado" or "Demerara" sugar in being pale yellow in colour, small-grained and almost free from molasses.

It should be added that the estimates of production of sugar and sugarcane in India are always expressed in terms of *gur* and that in the crop-cutting experiments on which the standard yields are based, the yield of *gur* per acre, and not cane, is recorded.

The revival of interest in the Indian sugar industry dates approximately from the commencement of the present century. It was about the time when in other parts of the world the application of the same scientific methods, which had enabled the beet-sugar industry to establish itself, put cane-sugar again on a level with, and subsequently far ahead of, its younger rival. Modern factories began to spring up, especially in North Bihar, where a European planting community existed and where indigo planting was becoming unprofitable. The Ottur, Japaha, Purtabpore, Marhowrah, Pursa, Bara-chakia factories in Bihar, Rosa in the United Provinces, and Nellikuppam in Madras, were all manufacturing sugar direct from cane before 1910. With the re-organisation of the agricultural departments from 1904 onwards, more attention was paid to the improvement of cane-growing, the economic value of the cane crop in Northern India being fully realised. Experimental work with the object of improving the indigenous processes of manufacture was also commenced about this time, and one notable advance was achieved, *viz.*, the introduction of the centrifugal machine for curing the sugar, accompanied by some improvements in the technique of open-pan boiling. By this time also the small iron two-roller bullock-driven cane mill had fairly completely replaced the earlier pestle-and-mortar and wooden-roller types, and three-roller iron mills were becoming known.

* The result of a recent census indicates that this was an over-estimate and that the amount of *khandsari* sugar now produced in the United Provinces probably does not exceed 100,000 tons.

The organised efforts which have led to the establishment of the present modern sugar industry really date from the commencement of the reign of His Majesty King George V. In 1910, a grant from the Government of India enabled Mr. Moreland, then Director of Agriculture, United Provinces, and the author of this paper, to arrange for a miniature modern vacuum-pan sugar factory, of one-and-a-half tons per day sugar capacity, to be supplied by Messrs. Blair, Campbell and Maclean and worked continuously throughout the season at the United Provinces Agricultural and Industrial Exhibition of 1910-11. In the year of His Majesty's Coronation an important discussion on the promotion of Indian sugar industry took place in the Imperial Legislative Council, a resolution being moved by the Hon. Pandit Madan Mohan Malaviya which recommended the raising of the import duty. In November of the same year, at the seventh meeting of the Board of Agriculture in India, the problems of the industry were considered in detail, the terms of reference being :—

(i) The improvement of the indigenous industry ;

(ii) The production of the refined sugar which is now imported ;

(iii) The possibility of extending the area under sugarcane in India.

The Committee of the Board on this subject included Mr. McGlashan, Manager of the Cawnpore Sugar Works. It had the benefit of considered notes from Mr. Shakespeare, a Director of Messrs. Begg, Sutherland & Co.—a firm whose pioneer work for the establishment of a modern Indian sugar industry is well known, and by Mr. Neilson, Manager of the Nellikuppam sugar factory, which dates from the first half of the nineteenth century, and as a modern concern, from 1897. The Committee's report, which was accepted by the Board and emphasised by a series of resolutions, made recommendations of cardinal importance. It was clearly shown that if the Indian sugar industry was to develop, or if even the existing area was to be maintained, the improvement of the sugarcane itself was a fundamental necessity, better cultivation and manuring being hardly less important. The report further stated that the economic importance of sugarcane cultivation to the country was such that active assistance from Government was amply justified in the national interest. Specific recommendations included definite programmes of agricultural work for the principal cane-growing provinces, the appointment of a Sugar Engineer to Government, that local governments should be empowered to give financial assistance to pioneer factories, and the most important recommendation of all was that a sugarcane breeding and acclimatization station should be established in Madras and that its most important work would be the production of better canes with purer juice. These recommendations were accepted by the Government of India and prompt action taken on them. Dr. Barber was appointed Imperial Sugarcane Expert, and the now famous Coimbatore Sugarcane Breeding Station was started in the next year. Thus were laid the foundations of a modern efficient Indian sugar industry. To avoid misunderstanding, it should be added that the Board made it abundantly clear that a radical

improvement in the raw material was as necessary in the interests of the indigenous *gur*-making industry and of the indigenous sugar industry as in those of modern central factories. Much of the Sugar Engineer's time and energies were devoted to experimental work with the object of improving indigenous methods and designing small factories.

The position in 1911

In order to gauge the progress since made, an attempt must be made to visualise the main features of the situation as they appeared to the Board of Agriculture in 1911. No statistics for the production of sugar from cane in modern factories were maintained until a much later date, but it is probable that less than 15,000 tons were so produced in 1911. The cane supply was far from satisfactory. In the United Provinces the local canes were not really ripe until the middle of January, and though the season nominally lasted from the middle of November to the middle of April, cane was not really fit to crush during the earlier part of the season. Most of the modern sugar factories then working were only able to get a recovery of six per cent sugar on cane. The best in Northern India that year touched seven per cent. The area under sugarcane in 1910-11 was 2,215,000 acres and the yield of *gur* 2,218,000 tons, corresponding to 11 tons of cane per acre and two-thirds of a ton of sugar. The standard yield for the United Provinces is now approximately two tons of *gur* per acre or 20 tons of cane, and with a nine per cent recovery 1·8 tons of factory sugar per acre. Yields of 30 tons per acre with improved varieties are now common, and one well-known concern—a self-contained estate in the Bombay Presidency—gets 47 tons of cane per acre, with an eleven per cent recovery or five tons of sugar per acre. The Board of Agriculture of 1911 was, therefore, justified in the emphasis which it laid on the improvement of the raw material.

Barber's work began to bear fruit almost immediately, but his most striking discovery, and one which subsequently revolutionised cane-growing in India, was his discovery of the value of the wild *Saccharum spontaneum*, better known as *kans* grass, as a parent for the production of hybrid seedling canes for Northern India. This, however, is anticipating a little. When the Sugarcane Breeding Station was started in 1912, the special problem confronting it was the production of improved types of cane suitable for the special sub-tropical conditions of Northern India. It had already been fairly clearly demonstrated that the mass introduction of "noble" canes from tropical countries was unlikely to be generally successful, and whilst acclimatization was included in the Coimbatore programme, it was in the production of seedling canes that the greatest hope lay. Sugarcane is normally grown from cuttings, but as with potatoes, recourse must usually be had to seedlings for the production of new varieties. The successful use in the production of hybrid canes in Java of an Indian cane *Chunee*, which subsequent research showed to be a natural hybrid with the wild *Saccharum spontaneum* as one parent,

pointed the way. The subsequent discovery by Jeswiet in 1916 of the great value in cane-breeding of the *kassoer* cane (found in a wild or semi-wild condition in Java and since proved to be a hybrid between *Saccharum spontaneum* and the Java Cheribon cane) was a further step forward. In Java the *Saccharum spontaneum* strain is now considered an essential element in the parentage of hybrid canes in order to ensure disease-resistance. Simultaneously with the raising of new seedling canes at Coimbatore and a study of their possibilities and limitations, a thorough survey of the Indian canes was made and a botanical classification worked out, the multitudinous agricultural varieties being arranged in groups. This provided a sound foundation for further work. Seedlings from both Indian and "noble" canes were raised and tested, and an important study made of the "tillering" of cane and its effect on yields, whilst a still more important study of the root-system of the sugarcane was commenced. Meanwhile, work was also being carried on in the provinces, especially at Shahjahanpur by Clarke. There both Coimbatore seedlings and some direct importations were studied in detail, and a Java seedling, distributed under the number S. 48, proved suitable for a substantial area in the United Provinces and was systematically distributed in suitable districts for some years. This cane occupied an area of some 94,000 acres in 1928-29, and it was not until about 1927 or thereabout, when Co. 290 proved its value, that a better cane for Rohilkhand was forthcoming. In other parts of the United Provinces Co. 213 had proved more suitable at an earlier date. Though a Java seedling, S. 48 came very near to the type required for Northern India, as it combined high purity, high sucrose-content and early-ripening with the hardiness and deep-rooting habit which appears to be necessary if a cane is to be successful in Northern India. Its introduction gave a marked fillip to the indigenous *khandsari* sugar industry, for which pure juices are essential. S. 48 was also a very acceptable cane for ordinary village cultivation for *gur* manufacture, and its introduction at a time when tube-well irrigation was becoming important was a definite encouragement to a higher standard of agriculture. At Shahjahanpur much attention was also given to the problem of nitrogen supply in connection with cane cultivation and an inexpensive and practical system of green-manuring and crop rotation was worked out and demonstrated.

The next landmark in the development of the Indian sugar industry, and an important one, was the appointment of the Indian Sugar Committee of 1919-20, a touring Committee presided over at the outset by Mr. MacKenna, Agricultural Adviser to the Government of India (now Sir James MacKenna), and later by Mr. Noyce (now the Hon'ble Sir Frank Noyce). This Committee made a thorough study of sugarcane-growing in India and of the condition of the sugar industry, visited Java and made a number of important and far-reaching recommendations, especially in regard to the organisation and finance of agricultural and technological research which, though pigeon-holed at the time, have since been of great service. The reason why prompt action was not taken on these recommendations was a

two-fold one. Financial stringency made itself felt not long after the Committee's report was issued—a circumstance which was largely responsible for delaying the establishment of that very obvious necessity, a central research institute for sugar technology—whilst constitutional changes were largely responsible for the decision not to set up a central sugar research board controlling experimental stations in various parts of India. Nevertheless, the report of the Committee did much to stimulate progress. More interest was shown in the industrial prospects of sugar manufacture and some new factories sprang up, a central sugar bureau for the collection and dissemination of information was established, provincial agricultural departments took sugarcane research more seriously, especially in the United Provinces, and most important of all, the Imperial Sugarcane Breeding Station at Coimbatore was made permanent and extended. Its founder, Dr. Barber, had just retired, but his lieutenant and disciple, Rao Bahadur Venkatraman, made a worthy successor.

At Coimbatore have been made four most important contributions to our knowledge of sugarcane-breeding. The importance and successful application of a wild sugarcane, *Saccharum spontaneum*, in the breeding of hardy canes has been demonstrated. By means of comprehensive anatomical studies has been established the importance of a suitable root-system to vigorous growth of cane, and the essential differences between the "noble" tropical canes and the canes of sub-tropical India in this respect have been ascertained and this knowledge applied to cane-breeding. It has added to our knowledge of the genetics of sugarcane and of the wild *Saccharums*. Lastly, Rao Bahadur Venkatraman has successfully produced numerous inter-generic hybrids between *Sorghum* (the great millet, vern, *juar* or *cholam*) and sugarcane. The economic value of this last discovery has yet to be evaluated, but it is a scientific achievement of great importance and its agricultural potentialities are obvious. It is hoped that a whole new series of early-maturing canes will eventuate from this hybrid. These successes have only been possible because important advances in the actual technique of cane-breeding operations have also beem made. The sugarcane inflorescence is imposing, but the actual flower is small and insignificant. The earliest "crossings" had to be made under a dissecting microscope on the top of a scaffold 20 feet high. Now it is possible, as the result of numerous improvements in technique, to raise annually several hundreds of thousands of seedlings of known parentage. What cane-breeding has done for the sugar industry in India can be demonstrated by a few figures. In 1910 the best material available to a sugar factory in Northern India was a thinnish cane containing, when ripe, about nine to nine-and-a-half per cent of sugar on cane, yielding only ten tons or so per acre on the average, unsuitable for intensive cultivation and only fit for crushing for about 70 days in the season. Now a group of canes is available covering the period November to April, yielding commonly 25 tons per acre and up to 35 tons with good cultivation, with a sugar-content on cane of 11½ per cent to 12 per cent. These are all hardy

canes suitable for village conditions with the hard rind necessary to render them unattractive to jackals, wild pigs and other enemies, and resistant to mosaic disease. When the Indian Sugar Committee reported in 1919, good factories were getting a recovery of six-and-a-half per cent; now the general figure for the United Provinces and Bihar is over nine per cent, mainly due to better raw material. The average normal yield of *gur* per acre in the United Provinces in 1919-20 was 2,600 lb. per acre; in 1934-35 it was 3,900 lb. on 1,560,000 acres planted with improved canes. Wherever Coimbatore canes are properly grown in the irrigated tracts of Northern India, a yield of 30 tons of cane, giving two-and-three-quarter tons of sugar per acre, is now expected.

But we must retrace our steps. When the Indian Sugar Committee reported in 1919, the results of breeding work at Coimbatore were only just becoming apparent. The first important group of seedling canes to be released was a set of four, Co. 205, Co. 210, Co. 213 and Co. 214. Of these Co. 213 was a main-crop cane, Co. 214 an early high quality cane though a lower yielder, Co. 210 a late good quality cane, whilst Co. 205 was found to be amazingly hardy. These canes had been tested thoroughly at various provincial stations and at Pusa, and in 1922-23 they were brought into general cultivation largely through the efforts of the Pusa SugarBareau and the co-operation of several sugar factories which provided part of the funds for the multiplication of stocks for distribution and gave special facilities for milling trials. The success of this group was phenomenal, and Co. 213 is now the most widely-grown cane in India. Giving, as a rule, 11½ per cent sugar on cane, it ripens well within the normal period for Northern India, maintains its quality well, has excellent standing power and is adaptable to a wide range of conditions. It is capable of giving yields up to 40 tons per acre with intensive cultivation, but is hardy. It has a hard rind protecting it from the ravages of jackals, wild pigs and the like and, as might be expected, the fibre content is comparatively high. The geneology of Co. 213 is of interest. One parent was the Java seedling P. O. J. 213, the other the Indian cane *kansar*; P. O. J. 213 in turn was a hybrid between the old "noble" cane Cheribon and the Indian *Chunee*, and thus had as one distant ancestor the wild cane *Saccharum barberi*. Co. 205 was a direct cross between a cane known as "Vellai" and *Saccharum spontaneum*, and for a time seemed likely to be grown on a very large scale indeed, for it was both drought-resistant and flood-resistant, and though as hardy as the most reed-like canes of Northern India, had quite a fair sucrose content and good yielding capacity. But it was hardly a good factory cane and though very tolerant of the mosaic disease, was susceptible to it. It is now rapidly being replaced by a later hybrid, Co. 285, but is still of interest as demonstrating the value of the wild cane parentage, for it has been a most valuable parent for the production of later hybrids. In 1926 another cane, Co. 281, which has achieved a greater reputation in Cuba than in India itself, was released—this was a hybrid between P. O. J. 213 and Co. 206, the latter being a cross between Ashy Mauritius and *Saccharum spontaneum*. Another seedling

released in 1926-27, Co. 290, was found specially valuable in Rohilkhand, being a high quality cane yielding purer juices than Co. 213.

The areas under improved canes in India have run as follows during the last 12 years :—

Areas under improved varieties of cane in India.

Year	Acres	Year	Acres
1923-24 . . .	60,604	1929-30 . . .	549,025
1924-25 . . .	75,334	1930-31 . . .	817,094
1925-26 . . .	171,808	1931-32 . . .	1,170,476
1926-27 . . .	207,989	1932-33 . . .	1,815,788
1927-28 . . .	268,088	1933-34 . . .	2,098,876
1928-29 . . .	301,093	1934-35 Probably exceeds	2,400,000

Detailed returns have not yet been published for 1934-35 except for the United Provinces, where the ascertained area under improved canes is 1,560,000 acres compared with 1,289,000 in the previous year. The area under improved canes in the United Provinces has been recorded annually in the village records for some years past. For other provinces the published estimates of agricultural departments have been taken, and these are apt to be conservative. In 1933-34 the shares of the other provinces were : Bihar 361,000 acres ; Bengal, 175,000 acres, Punjab, 174,000 acres ; Madras, 59,000 acres ; Bombay, 10,000 acres, and Assam, 9,000 acres. Of this area, Coimbatore seedlings occupy by far the greater proportion, Co. 213 predominating in the United Provinces and Bihar. In Madras and Bombay the " noble " or tropical canes still predominate, and in the Bombay-Deccan, with liberal cultivation, the Java seedlings P. O. J. 2878 and E. K. 28 do even better than Co. 290. The newer canes under local testing are in many ways superior to those in cultivation, and some are particularly promising. Naturally a more rigorous testing is now insisted upon before a new cane is put into general cultivation. Similarly, a number of thick seedling canes from South India from the other branch of the Coimbatore Breeding Station are under trial. This, however, is only a beginning. Higher tonnages, enhanced hardiness and higher sucrose percentage are needed, and canes possessing these characters are now under test all over India. Fundamental as is varietal improvement, it is by no means the sole consideration, and to secure anything like satisfactory tonnages both better tillage and adequate properly balanced manuring are needed. As a manufacturer of carbohydrates the sugarcane plant is unrivalled in efficiency. In Java over nine tons of sugar per acre have been obtained by individual factories. Groups of factories have averaged nearly seven tons per acre, whilst the average for 168 factories in 1932-33 was 5·9 tons of manufactured sugar per acre. Compared with this even the world's record yields of rice and wheat pale into insignificance.

But the necessary plant food must be supplied, and here India still lags sadly behind other countries. Much work has been done in this direction, and the agricultural departments throughout India are now in a position to make definite recommendations and are doing so. Clarke's work at Shahjahanpur cleared up the essentials of the position in the United Provinces and indicated quite clearly the immediate lines of advance. In his Presidential Address to the Agriculture Section of the Indian Science Congress in 1930, Clarke placed intensive cane cultivation in the United Provinces in its true perspective as part of a better system of agriculture and showed very clearly that by adopting better methods of cultivation well within the powers of the ryot, high yields both of cane and of the rotation crops could be secured. In his evidence before the Tariff Board he showed that by such methods good-quality cane could be produced at not more than four-and-a-half annas per maund, or seven rupees ten annas per ton.

The slump in prices of all agricultural produce and a consequent tendency to expansion in the sugarcane areas has momentarily obscured this aspect of the question. But it is of equal importance to the continued progress of Indian agriculture and to the maintenance of an efficient sugar industry, and demands unremitting attention.

In his paper read before the Society in 1928 Sir James MacKenna stated the importance of the Central Government taking an active interest in sugar research in India, and put forward the view that this matter should receive the early attention of the Imperial Council of Agricultural Research, the creation of which the Royal Commission on Agriculture had recommended. A brief reference may, therefore, be made to the steps which have been taken within the last five-and-a-half years to promote the healthy development of the Indian sugar industry. On the establishment of the Imperial Council of Agricultural Research in 1929, the Government of India referred this question to it for urgent consideration. In an interim report of the Sugar Committee appointed by the Research Council were set out the *prima facie* grounds for fiscal protection, and it was requested that the matter be referred to the Indian Tariff Board. This was done; the Sugar Committee and staff of the Research Council prepared material for the Tariff Board, and it is now a matter of history that fiscal protection was granted. Simultaneously, the Committee considered the immediate needs as regards sugar research, technological training and technical assistance to the industry. In this task they derived great assistance from the report of the Sugar Committee of 1919-20. The Government of India has since provided various sums aggregating Rs. 20 lacs for sugar research, for financing, on a five-year basis, various research schemes put forward by the Committee and approved by the Research Council. As the report of the Indian Sugar Committee had clearly shown that the high efficiency of the Java industry was due in large measure to mutual chemical control and the interchange of detailed factory results and technological information, a sugar technologist with high

qualifications and successful factory experience was appointed early in 1930 in order that intending factory owners might be advised in the selection of sites and machinery and existing factory owners aided in technical matters. The Sugar Bureau was transferred to the charge of the sugar technologist and a beginning made in the collation of the requisite technical and statistical data. A grant was also made to the Sugar Technology section of the Harcourt Butler Technological Institute, Cawnpore, to provide a complete miniature modern sugar mill for instructional and experimental purposes, whilst an annual grant was given towards the recurring expenditure of the section on the condition that a specified number of free students from other provinces would be admitted to the course on the nomination of the Research Council.

On the agricultural side a grant was made to the Imperial Sugarcane Breeding Station which enabled a sub-station to be opened at Karnal in order to improve the facilities for selecting new seedlings suitable to Northern India conditions. Hitherto preliminary selections had to be made at Coimbatore under quite different conditions—a double disadvantage, as the seedlings most suited to sub-tropical India might easily be missed whilst the testing process was unduly prolonged. Grants were made which enabled cane-testing and research stations to be opened throughout the main sugarcane belt of Northern India, *viz.*, at Jorhat in Assam, Dacca in Bengal, at Mushari (near Muzaffarpur) and at Patna in Bihar, at Muzaffarnagar (in addition to extensions at Shahjahanpur) in the United Provinces, and at Jullundur and Lyallpur in the Punjab. Similar experimental stations were added at Padegaon in the Bombay-Deccan, and near Chittoor and at Anakapalle in Madras. A special grant for breeding work on thick canes was made to the Mysore Agricultural Department. This chain of experimental stations is a most important feature. At them new seedling canes are tested on a co-ordinated plan, growth studies are made, and cultural and manurial experiments are carried out. It has been found possible to transport both actual sugarcane seed and tiny seedlings from Coimbatore to some of these sub-stations for study and selection under local conditions. A grant was made to the Pusa Research Institute for the study of the mosaic disease of cane and of other cane diseases and a scheme of work on the insect pests of cane has recently been approved by the Governing Body of the Council. Nor has the improvement of indigenous methods been neglected. A special experiment station is being started near Moradabad for experimental work on the improvement of *gur* manufacture and small-scale sugar manufacture. Finally, the Government of India has recently announced its approval of the scheme formulated by the Sugar Committee for a central sugar-industry research institute for technological research and instruction, at an estimated cost of one-and-a-half lacs initial and two-and-a-half lacs of rupees recurring. It is proposed to locate this institute at the Harcourt Butler Technological Institute by arrangement with the United Provinces Government, and the work of the present sugar section of that institute will be suitably expanded and developed. The programme of

work proposed for the new institute is sufficiently important for detailed mention. It includes—

(i) Research on Indian sugar factory problems and in sugar technology in general, including the utilisation of by-products, with special reference to Indian conditions.

(ii) The provision of scientific assistance to factories.

(iii) Extended tests under factory conditions of new varieties of cane.

(iv) Collection and tabulation of scientific control returns from factories and technical reports.

(v) Critical study of the working of Indian factories and a comparison of the results with the best Indian practice and results obtained in other countries.

(vi) Advice to factories on difficulties and faults disclosed by their returns.

(vii) Training of students in all branches of sugar technology.

(viii) Demonstration of improved methods and equipment and refresher courses for men already engaged in the industry.

Though the Government of India did not give legislative effect to the recommendation of the Tariff Board that a statutory allotment of ten lacs of rupees (£75,000) per annum should be made for sugar research, it gave a definite, though guarded, undertaking to the Central Legislature that reasonably adequate funds would be provided for this purpose. The allotments referred to above have been made in fulfilment of that promise. The framework has been constructed of an adequate research organisation which should go far to ensure the healthy development of an efficient industry—provided, of course, that adequate financial provision is made in future as in the past.

A word may be said about the level of tariff protection enjoyed by the industry at present. The Tariff Board recommended a protective duty of Rs. 7/4/- per cwt. with a deferred additional duty of eight annas in the event of imported sugar at Calcutta falling below a certain level. The summarised recommendations of the Board were placed before the Legislative Assembly in March, 1931, and the revenue duty was raised to Rs. 7/4/- per cwt. In November of the same year, when the emergency 25 per cent surcharge on all customs duties was imposed, the import duty on sugar became Rs. 9/1/- per cwt. In April, 1932, the Sugar Industry Protection Bill was passed ; this gave the industry fiscal protection for a period of 15 years, fixed the protective duty at Rs. 7/4/- per cwt. for a period of seven years, provided that the amount of the protective duty for the succeeding eight years should be fixed in 1938 after an inquiry, and gave power to Government to increase the import duty, to such an extent as might be necessary, in the event of

sugar being imported into India at such a price as to render the duty of Rs. 7/4/- per cwt. inadequate to maintain protection at the intended level. The surcharge still being in operation, the actual import duty remained at Rs. 9/1/- per cwt.

As a result of this sequence of events, the sugar industry secured, even before the Sugar Industry Protection Act was passed, tariff protection which for the time being was substantially in excess of that recommended by the Tariff Board. Simultaneously there occurred a fall in cane and *gur* prices which was largely due to the general slump in the price of agricultural produce. At about the same time there was a substantial drop in world prices for heavy machinery, whilst openings for profitable industrial investment in India were few. This combination of additional stimuli led to an unexpectedly rapid expansion of the sugar industry and to development for which the Tariff Board allowed at least seven years being concentrated into three. The all-India Sugar Conference which met in Simla in the summer of 1933 made public the fact that the advance was in danger of being too rapid and that acute internal competition for the Indian sugar market was in sight. It also transpired that the sugarcane grower had not received his full share of the benefits of protection.

Two important legislative enactments took place early in 1934. These were the Sugar Excise Act, 1934, and the Sugarcane Act, 1934. The sugar excise duty was imposed for financial reasons in order to make good part of the revenue lost by the sudden and drastic reduction of sugar imports and their impending disappearance. The level of the duty was so fixed as to reduce the quantum of protection to that recommended by the Tariff Board by off-setting the customs surcharge. Since the c.i.f. price of imported sugar had fallen to a level which, had the surcharge not been in operation, would have justified the imposition of the deferred duty of eight annas per cwt., the excise duty was fixed at Rs. 1/5/- per cwt. and not at Rs. 1/13/-.

The Bill aroused considerable controversy, and the report of the Select Committee and subsequent debates in the Legislative Assembly showed that the question whether the imposition of the excise did in fact leave the industry with a proper measure of protection was very thoroughly argued. From this discussion the following conclusions emerged: The Tariff Board's recommendations were based on a calculated "fair selling price" which, in turn, depended on certain fundamental assumptions, the principal of which were the following:—

(i) At the outset many factories would have to pay eight annas per maund of 82·3 lb. (*i.e.*, Rs. 13/10/- or 20*s.* 5*d.* per ton) for cane, this price falling to six annas at the end of the protective period.

(ii) That a recovery of nine per cent of saleable sugar on the cane crushed could be assumed.

(iii) That molasses could be sold at Rs. 1/8/- per maund, corresponding to a reduction of ten annas eight pies per maund of sugar in the cost of production.

(iv) The average factory would crush 13,00,000 maunds of cane, or nearly 50,000 tons, per season.

(v) The capital cost of a factory of this capacity would be 13½ lacs of rupees.

When the position was reviewed in March, 1934, it was found that—

(a) Five annas to six annas would be a more representative price for cane and that in the season 1932-33 some very successful factories had paid only four annas per maund;

(b) The estimate that efficient factories would obtain a recovery of nine per cent sugar on cane was confirmed by experience;

(c) Except in favoured instances, molasses no longer fetched anything beyond a nominal value. The reason for this was that the ultra-rapid multiplication of modern sugar factories had resulted in a sudden increase in molasses production of such magnitude as to disorganise the trade in that product;

(d) The average capacity of factories had turned out to be about 1,800,000 maunds of cane per season, or say 66,000 tons, as against 1,300,000 maunds, the increase being due in part to machinery of larger capacity being installed, and in part to a longer working season being possible;

(e) The allowance to be made for depreciation had dropped from eight annas to less than six annas per maund of sugar, whilst a return of ten per cent on capital now meant just over 13 annas instead of one rupee two-and-a-half annas per maund of sugar.

As a result of these changes, the "fair selling price" of sugar with cane at five annas per maund, calculated in the same manner as by the Tariff Board, now came to seven rupees per maund in round figures, exclusive of the excise duty, or to eight rupees if that duty, which is paid in the first instance by the factory, is included. This was a substantial reduction on the Tariff Board's original figure of Rs. 9/5/9 per maund. Making due allowance for the fact that the freight advantage has already disappeared and that Indian factories are now selling their sugar at the ports, it was a fair conclusion that the imposition of the excise duty would adjust the protection which the industry enjoyed to the level recommended by the Tariff Board. This view the Central Legislature accepted.

The important question of securing to the cultivator a fair price for his cane had also to be tackled. The information placed before the Sugar Conference had shown quite conclusively that the prices paid for cane during the preceding season had been unsatisfactory in many cases and that although many factories had treated their suppliers very fairly, cane-growers in general were not receiving a fair share of the benefits of protection. The practicability and desirability of factories paying for cane on a sliding scale based on the price of sugar was pointed out by

the Indian Sugar Committee as far back as 1919, and the Tariff Board endorsed this view. Although the Board did not recommend such scales being made compulsory, there was no inconsiderable body of public opinion in 1932 which would have welcomed the inclusion of some such provision in the Sugar Industry Act. In April, 1934, the Sugarcane Act, being "An Act to regulate the price of sugarcane intended for use in sugar factories," was passed by the Central Legislature and has been in operation during the current season. The Act is of an enabling character, and it is left to Provincial Governments to apply the Act to the whole or any part of province as they think fit. Once the Act comes into operation in a province, the minimum prices fixed for sugarcane required the approval of the Central Government. Briefly, the Act empowers local governments to fix minimum prices for sugarcane intended for factories, to prohibit the purchase of cane except from the grower or from a licensed cane-purchasing agent, and to make rules regarding weighments and other matters connected with the administration of the Act. The Act is now in operation in the whole of the United Provinces and in North Bihar, *i.e.*, in areas which include approximately 96 factories out of a total in India of 142. In both provinces the orders published at the commencement of the season required the minimum price of cane to be fixed on a sliding scale, a basic price of five annas per maund of cane corresponding to an average price of Rs. 8/8/- for No. 1 sugar for factory delivery, each rise or fall of eight annas in the price of sugar resulting in a rise or fall of one-quarter anna in the minimum price of cane. The actual minimum prices are notified fortnightly. For *khandsari* factories, *i.e.*, factories, as defined in the Factory Act, which do not employ any type of vacuum-pan or vacuum-evaporator, a lower sliding scale with a basic minimum price of three-and-a-half annas has been prescribed.

During the present season the minimum prices have been steady at or near five annas, whilst the actual prices paid have varied from about five to six-and-a-half annas per maund. It should be noted that the minimum price has to be paid at whichever of a factory's weighing stations a grower delivers his cane, any subsequent freight and other charges being paid by the factory. As the rules stand at present *premia* can be, and are, paid for cane of better quality, for cane of special varieties, or where local prices are high. But deductions for poor quality are illegal, and if cane is accepted at all, the minimum price must be paid; a temporary exception was made for frost-damaged cane. Where the Act is in operation, factories are also prohibited from purchasing cane except from the grower or from a duly licensed cane-purchasing agent. By this means it is hoped to eliminate the irresponsible cane contractors who have been a bane to growers and factories alike. This Sugarcane Act also enables rules to be framed for the organisation of sugarcane growers into societies for the sale of cane to factories.

Many of the abuses which have been the subject of recent complaint had their origin in the fact that the growers of cane are numerous and unorganised, and

the average holdings small. It is in such circumstances that unscrupulous midd'emen thrive. Recognising that the interests of the growers and factories alike demand the better organisation of supplies, the Government of India has undertaken to set aside annually a sum equal to one anna per cwt. of the sugar which pays excise, for distribution to the sugar-growing provinces for expenditure on approved schemes for the better organisation of sugarcane supplies. This step was, perhaps, even more important than the Sugarcane Act itself. The cane-sugar industry differs from almost all other great industries in its dependence on regular and adequate supplies of fresh raw material. Other industries concerned with the processing of agricultural products can store at least part of their raw material for substantial periods, but in the case of sugarcane this is not so. When, as in India, a factory's supplies of cane have to be drawn from numerous small growers, a high degree of organisation is essential in the interest of both parties. Legislative action enables the grosser abuses to be controlled, but this is only a first step. Payment for cane will eventually have to be on the basis of quality, and there is clearly a need for planned and balanced production of early, medium and late maturing types. Until far closer co-operation between factories and growers, and a practical realization of their unity of interest, can be achieved, the real problems of the Indian sugar industry will not have been solved. The sum available for this purpose should reach something like seven lacs per annum by next year if present estimates of production are correct, and some ten lacs per annum eventually. This is a substantial sum, but not out of proportion to the objective.

Already there are signs of progress apart from Government effort. Transport arrangements are being improved. A few far-sighted factories have put in steam tramways, whilst in parts of North Bihar the pneumatic-tyred land wheel for bullock-drawn carts promises greatly to simplify transport on unmetalled roads. Several co-operative sugar factories have been started, one in the United Provinces being of special interest, as it is of normal capacity with very modern plant, many of the shareholders being not individuals, but primary cane-supply societies. In the same province the hydro-electric branch of the Irrigation Department has established a special type of vacuum-pan factory in the "grid" area where cheap electric power supplements steam raised from the megass, thus making a smaller unit possible. Such factories, if successful, would replace the *khandsari* factories which work the open-pan process. Attempts are thus being made from several angles to solve this important problem of organisation on which so much depends.

Nor is the organisation of raw material supplies the only desideratum. If the huge Indian market is to be served to the best advantage, sugar marketing must be better organised than at present. This fact has been realised, and the two trade associations which now include most of the modern sugar factories, *viz.*, the Indian Sugar Producers' Association and the Indian Sugar Mills' Association, are now trying to secure more orderly distribution of sugar and better-organised sales.

To this end, the Sugar Bureau has started a self-supporting Indian sugar-trade information service, and the Sugar Technologist is assisting in the preparation of suitable standards for Indian sugars. There is also an active association of sugar technologists, which gives the technical staff of factories an opportunity of discussing scientific and technical details. These steps towards the better organization of the industry itself are all to the good, for, as has been repeatedly pointed out during the last 15 years, the success of the Java sugar industry was due almost as much to excellent organization as to natural advantages.

Earthquake damage

No account of the Indian sugar industry would be complete unless reference were made to the effect of the great earthquake of January, 1934, and to the successful steps taken to mitigate its effects. The earthquake was severely felt throughout the greater part of the North Bihar sugar area, but fortunately its effects on the industry were largely temporary. There were operating, that season in Bihar, thirty-three sugar factories, twelve of which were working for the first time, and of these twenty-eight, including eight new ones, were in North Bihar and fifteen in the Tirhut Division, where earthquake damage was most serious. Eight factories were seriously damaged (three in Champaran district, two in Muzaffarpur district and three in Darbhanga district) and the damage to machinery and buildings has been put at 20 lacs or, say, £150,000. Most fortunately, only two factories were so damaged that they could not be re-started before the end of the season. The damage to the standing cane crop was not very serious, but the putting out of action of eight factories in the middle of the season and the dislocation of transport meant that some 550,000 tons of cane had to be disposed of. It was essential that this problem should be solved because sugarcane is the principal cash crop in this very densely-populated area, and the misery caused by the earthquake would have been greatly intensified had the *ryot* been unable to dispose of his cane to reasonable advantage. Of this quantity about one-fifth was taken up by the damaged factories after they re-started and about 120,000 tons by the other factories of the earthquake area. A further quantity of about 100,000 tons was transported to factories outside the earthquake area by a specially constituted Cane-marketing Board. In this operation the Cane Board received the fullest support from the Bengal North-Western Railway Company and also from the Indian Railway Board, which promptly placed additional metre-gauge wagons at the local railway company's disposal. No fewer than 19 factories co-operated with the Cane-marketing Board in the disposal of this surplus cane. Though this may have involved a financial sacrifice, at least in some cases, it was a wise move, for it did much to restore confidence amongst cane-growers and to insure future cane supplies. The remainder, a matter of 220,000 tons of cane, was converted into *gur* by the usual indigenous method. The importance of the last means of disposal became obvious

as soon as the Bihar and Orissa Agricultural Department reviewed the position. In many parts of India *gur*-making would have increased automatically but North Bihar had become so largely a white-sugar tract that bullock cane mills and *gur*-boiling, pans no longer existed, and *gur*-making had gone out of fashion in many villages. For once progressive methods proved an embarrassment. This difficulty was soon overcome. The Government of India made a special grant which enabled 3,469 cane mills and 3,272 *gur*-boiling pans to be lent free of charge to cultivators in the stricken area, and the staff of the Agricultural Department demonstrated how *gur* was made in olden times. The shock to the cane-grower was thus greatly lessened and it is satisfactory to note that the planting of the new crop was practically normal.

The earthquake naturally had an unfavourable effect on the working of most factories in and near the affected area. Seven of the damaged factories had an average working season of 93 days, compared to 163 days in the previous season, and the percentage of sugar to cane averaged only 7·9 per cent compared to 8·5 per cent in 1932-33. This was unavoidable, for operations were interrupted during the best part of the season, and the damaged factories re-started when the cane was dry and over-ripe, whilst much stale cane had to be handled due to transport difficulties. Fortunately, all factories are working normally this year and the dislocation, grave as it was, proved less disastrous than was feared at the time.

Conclusion

Of the future of the industry it is perhaps unwise to prophesy. The season 1935-36 will see about 145 modern factories in operation, with an estimated combined capacity of 810,000 tons of sugar per annum—a quantity which approaches very closely to India's total requirements of factory sugar. Approximately 120 of these factories are in Northern India, fifteen in Madras and South India, and the rest in Bombay and Burma. For further expansion in Northern India there is little room, except in the replacement of *khandsari* concerns—a process which has already begun. In South India and Bombay some expansion is expected and is likely to be gradual. That there is scope for an increase in the consumption of sugar will be clear from the fact that India's average consumption of factory sugar alone for the quinquennium ending 1930-31 was 961,000 tons. In favour of an increase of consumption is the fact that, despite the increased duty, sugar prices are now substantially below those of 1929-30 throughout India—the difference naturally being most marked in Northern India. On the other hand, the general level of prices of agricultural produce is low, and with an abundant supply of cheap *gur*, rural consumption of factory sugar is likely to keep low. Hence any marked increase in sugar consumption may have to await an increase of general prosperity.

Most of the Indian sugar factories are equipped with good machinery and are fairly well adapted for handling Indian cane, both as regards machinery-design and the balance of different sections of the factory. To this statement there are definite exceptions, for some factories are distinctly faulty, but on the other hand several factories are much above the average. There is unfortunately, a much greater diversity in the standard of factory management and in many instances, even where the factory is large enough to justify a full technical staff, an inadequate staff is employed. Here also there is recent evidence of improvement, and the sugar technology courses at Cawnpore have contributed considerably to this end.

Intrinsically the industry is sound, and there is every reason to believe that the weakness associated with an unexpectedly rapid development will soon be rectified. This much is certain: during the present time of agricultural depression, the sugarcane crop has been the one redeeming feature in thousands of villages in Northern India. It is at all times a crop which gives the Indian cultivator a relatively large reward for his labour and gives him employment throughout the year. The growth of the sugar industry, whatever its imperfections, has added substantially to the cultivator's resources, whilst it is no exaggeration to say that the introduction of improved canes in Northern India has meant the difference between a cultivator's ability or non-ability to pay his rent or land revenue.

For what has been said in the course of this paper I can lay little claim to originality, and my sources of information have been many. I desire to acknowledge my indebtedness to many friends, and particularly to the late Dr. Barber, to Mr. Noel Deerr, Mr. Clarke, Mr. Wynne Sayer, Mr. R. C. Srivastava (Sugar Technologist to the Imperial Council of Agricultural Research) and Rao Bahadur T. S. Venkatraman for much of my information, and to the last-named for the kind loan of lantern slides. Lastly, I owe a debt of gratitude to Sir Harry Lindsay, who has so kindly undertaken the thankless task of reading another man's paper.

THE SHOW STANDARDS OF CATTLE

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Within recent years, there has been a good deal of discussion concerning the conformation of the dairy cow and its relation to milk production. There has been much dispute concerning the value of show type for commercial purposes. The showyard is being criticized. This has now led to questions concerning the value of our pedigree breeds of dairy cattle and it is stated that the methods employed by British stockbreeders in the past have been fundamentally unsound and that we are at the present day following a will-of-the-wisp policy of live-stock improvement. The culminating criticism is that, in view of either modern requirements or scientific advances, or both, we should scrap our present methods and breeds and start afresh our whole work of dairy cattle improvement. To the majority of those who are connected with the dairy cattle industry, the final conclusions of these critics, as recently voiced, appear absurd. The present era, however, is one of new methods and viewpoints. However outrageous such criticism may appear, it behoves us to examine it from a double standpoint. Is it sound economically? Is it based on scientific fact?

Scientific evidence.—Let us first deal with the scientific aspect. Much has been written concerning the inheritance of milk yield. Unfortunately the greater part of this work is based upon mere observation, as distinct from ascertained fact. The scientific investigations on this subject are not numerous, but they are as many as could be expected, considering the rate of reproduction in the cow. The majority have been made in the United States.

From the evidence available the following facts are clear :—

Total yield of milk is largely conditioned by heredity.

Nutrition and environmental factors are important and cannot be neglected.

Total yield of milk is inherited in no simple manner.

Quality of the milk is largely inherited, and is to a much lesser extent affected by nutrition and environmental factors.

The amount of fat secreted by a cow is, to a very large extent, inherited independently of the total yield of milk. As regards the other constituents, casein, sugar, hardness of curd, size and shape of the fat globule, and each of the principal minerals (except iodine), there is reason to believe that the same holds good.

All these points are reasonably well proved, and while nothing is ever certain, they can be taken as the basis for future work. Indeed, if the scientific method is worth anything, these facts must be used as the stepping-off place both for further scientific work and for practical stock improvement.

The inheritance of milk yield has long been recognized by practical stockbreeders to be a problem of great complexity, and it is therefore but natural that the breeder should look to the geneticist for some method whereby the workings of heredity might be accelerated—the more so as the life of the dairy cow is short when compared with the time taken to prove her milking capacity. The average life of a dairy cow is about six years. She is three years old before any general assessment can be made of her productive qualities and is four years of age before this figure can be obtained with any degree of accuracy. Accordingly, the breeder has evolved a lore concerning the relation of the form of the dairy cow to her productive capacity, a lore that is also applied to the dairy bull. It is this lore that has become the foundation of our showyard system and that is now being so violently attacked.

As far as science is concerned this lore falls into two parts. The first relates to the points that are capable of scientific measurement, and the second to those that have so far defied accurate measurement. Of the measurable points of the dairy cow, certain definite correlations have been found between form and function. With a few exceptions the relationship is so small as to be barely worth further consideration from the practical aspect of stock improvement. Other things being equal, size, as measured by weight, bears a direct correlation to total yield. Thus it is that the progeny of certain bulls show an increased yield principally owing to the fact that their sire transmitted a big body rather than a big yield. Obviously, an Ayrshire cow will give more milk than the larger matron of the Scotch type of Shorthorn. Size is only an accessory factor towards increased production. To a lesser degree, certain measurements such as length, girth, etc., bear a similar relation to total yield of milk.

There is definite scientific evidence that conformation on the whole is no sound criterion of the true milking capacity of a cow. Especially as regards the shape of a heifer there is nothing measurable that can yet be considered to be of the slightest value as an indication of the amount of milk she will give when she calves. Indeed, scientific evidence points to the fact that it is definitely unsound to attempt to prognosticate the yield of a heifer either by measurement or by eye.

The other aspects of form—those that are not amenable to measurement—are probably of some importance, since they relate principally to the organs of milk secretion. One of these that has been scientifically examined, namely, the diameter of the milk wells, shows a definite correlation to productivity. It is, therefore, reasonable to assume that breeders, both past and present, are justified in taking into account the mammary development.

It has been shown, however, that the nature of the escutcheon (the area of skin between the hind legs stretching from the udder to tail head) is no indication of milking capacity. Where a positive correlation has been obtained between the shape of the escutcheon and yield of milk, this may be attributed to the fact that, owing to the escutcheon shape being hereditary, there has been in that particular strain of cattle, a chance association of yield and escutcheon. This fact gives us a clue to one reason why so many breeders have associated form with production, particularly as regards points of conformation of no obvious utilitarian value. A breeder has a high-yielding cow with, let us say, a particular shape of ear. He remembers that the dam of this cow had both these qualities and notices that amongst the daughters of the son of this cow most of the high-yielders have also got ears of this particular shape. He therefore concludes that the ear shape is an indication of production, when the fact is that the association is more or less a chance one. It may, however, be of value to him in the selection of high-yielders of that particular strain. It also may not. If he finds it is, the breeder tells his son of his observation. The son accepts it as gospel and it becomes incorporated in breed type. As generations of cows pass on, the association becomes weaker, but the belief is apt to become greater. This is where so many pedigree breeders have been led astray.

As the outcome of scientific observation it may be accepted that it is unwise to use conformation as a guide for the selection of cows with a high capacity for milk production: but this does not imply that conformation is without value. Unless a cow is capable of producing a minimum quantity of milk she is not a dairy cow no matter that she may belong to dairy breed. Even if she does produce an adequate quantity of milk, she may still be unsuitable for commercial milk production. An adequate yield of milk as regards both quantity and quality is a pre-requisite, but there are other points of equal importance.

Amongst these points are characters that affect the length of life of the cow, and others that affect her economic utilization of food or her powers to breed at regular intervals. If any of these characters can be shown to have any relation to conformation, then the principle of the method on which selection is at present based can be justified.

Take longevity first; it is the cow that produces 10,000 gallons in her lifetime that is more remunerative to her breeder than the cow that can produce 2,000 gallons in one lactation but cannot keep it up. We must recognise that in breeding for high production, we are selecting for a type of mammary apparatus that puts a severe strain upon the other organs of the body. It is as though in the thoroughbred horse we were to select for ability to move at great speed but, at the same time, were to neglect the development of the heart. It is the thoroughbred that can win races throughout a long life that is remunerative to its non-betting owner.

The qualities that make for longevity are various and cannot all be described here. Amongst the most important are the legs and feet. Crooked hind legs,

poor pasterns, and soft hoove. are causes of serious loss in our dairy herds and are definitely of genetic origin. Because of undesirable hind legs, some high-yielding cows become absolutely worthless. If a cow has the right hind feet and legs, she can stand on concrete for fifteen or twenty years and she can travel to pasture without pain or trouble. It is very easy to get poor legs into a herd and the only way to prevent this defect is to select breeding stock by conformation.

As well as being a possible measure of production, the shape of the udder is important from this point of view. There are good producers with capacious but otherwise badly-shaped udders: such udders are more subject to injury. Each quarter should be evenly developed and the udder should not be pendulous or cut up. The properly-built udder is protected from injury, is not so likely to be stepped upon and is much easier to keep clean. It is usually in the udder that cows show the first sign of unsoundness. Again, with the advent of the milking machine, the correct placing and size of the teats is a matter of great importance.

With regard to the economic utilization of food, it is essential that a dairy cow should have plenty of capacity—both of chest and of digestion. A high producer may occassionally be flat in the rib, but it is seldom that she is an economic producer of milk when examined from the point of view of food consumption.

The saner objections to the show standards have centred around such descriptions as, " a clean cut feminine head with plenty of character and style, plenty of width between the eyes, etc., etc." Whether there is any correlation between these qualities and milking capacity has never been directly scientifically determined. No one will dispute, however, that the appearance of the head of a cattle beast gives an indication of sex whether the animal be bull, steer or cow: but this indication is not infallible. There are cows with heads like steers. Likewise there exist effeminate bulls. If, in an animal of either sex the reproductive organs cease to function fully, then, in accordance with the degree to which the sex organs are upset, the appearance of the animal changes in the direction of an intermediate or neuter type, or may even approach the type of the opposite sex. Thus, the appearance of an animal is governed by the functioning of the sexual organs, which also govern both milk secretion and fertility. Hence it is not illogical to assume, as practical breeders have done, that there is a valuable connexion between the head, as an indication of sex and the economic worth of a dairy cow.

To sum up the scientific evidence it may be stated that the existing method of the breeders, based on a correlation of form with function, is not unsound. While conformation of the dairy cow may give small indication of the capacity the organs of milk secretion, it is of definite value as regards other qualities that are of prime importance from the standpoint of lifetime production.

The economic aspect.—Such being the scientific evidence the situation in England may now be examined from her rather peculiar economic standpoint. No other country in an advanced state of agriculture has so many cattle of the dual-purpose type. Some other countries wish they had, while others are content as

they are, but that is not the present issue. The dual-purpose animal suits a certain type of farm economy prevalent in England. So far, no measure has been devised—or is likely to be devised in the immediate future—whereby the breeder may assess the value of the carcass of an animal on the hoof other than by the eye. Hence, conformation is fundamental in the selection of animals of the dual-purpose breeds.

"To every action there is an equal and opposite reaction." It must be admitted that in every breed of live-stock there has been a period when the principal breeders set undue store by some character whose economic worth was trifling. That some breeds diverged further than others from the economic path is probably the reason for the present criticism, but does not justify the conclusions at which the critics are arriving.

Our pedigree system is not at fault. Like other British institutions it requires some adjustment, especially at a time of economic stress such as the present. The same holds good as regards the show-ring. Yet let it be recognized that it is the pedigree system and the show-ring, together with the native wit of the stock raisers of England—and more latterly of Scotland—that have given the breeds evolved in these islands—including the Channel Islands—the predominant position they now occupy in the agriculture of the world. There is only one breed of cattle of world-wide reputation that has not originated in the British Isles. For the future, as science devises measures of production and as it discovers more exactly the manner in which specific characters are inherited, so must these be incorporated into our methods of stock improvement and be grafted on to the art of breeding, just as we are now witnessing the incorporation of milk recording into the old methods of pedigree breeding and its grafting on to the ancient principle of the progeny test, so much used by the early breeders and for which the foundation is pedigree.

It is perhaps the show-ring that most requires adjustment to modern conditions. As Professor Scott Watson has said, the art of "bringing out" stock has made more progress than the art of breeding. More emphasis requires to be laid upon definite evidence of milking capacity before a cow can be entitled to the prefix "dairy". There should be more place given to tests of families, daughters of one sire, etc. Also there should be a class for cows that have given over 10,000 gallons and for which every entry forward should receive a prize. When shows were first started the educational aspect was first and foremost in the live-stock exhibits. Our show societies have not forgotten this, as witness the incorporation in their programmes of young farmers' judging competitions, etc., but they can advance still further.

Against the present system it is argued that the live-stock of to-day are no better than the stock of a century-and-a-half ago. That is not true. Undoubtedly there were at that period some high-producing cows, even after making allowance for the fact that milk was not weighed but measured by volume, as delivered from

the cow, complete with froth, and that it is difficult to determine whether the pints and quarts were Imperial or local. The point is that proportionately there were not so many high-producing cows as there are now-a-days. Moreover, the average production of the dairy cow was not so high as it is at present. It is true that there are no figures to show the yield of the cow of 150 years ago : but there is no question that the yield has definitely improved during the past thirty years. Take only the figures of the officially milk-recorded cows. Annually these show a small but usually consistent increase. Since 1918, despite the fact that the number of recorded cows and heifers has been increased seven-fold, their average annual yield has gone up from 600 gallons to 700 gallons, *i.e.*, an increase of nearly 17 per cent. It may be argued that this is due to better methods of nutrition. That is in part the truth : but within the past few years, the dairy farmer has had little incentive to feed for maximum production and to force his cows to the utmost. In addition, improvements in methods of nutrition can only be effective if the cows have the inherent capacity to respond to the increased feeding.

Here are the recent figures of cows officially recorded in England, classified by breed, showing the numbers and the average yields of cows for the years ending October 1, 1929 and 1933 respectively. In studying the figures of the latter year it must be remembered that the price the farmer obtained for his milk was appreciably less than in the earlier year. The Index figure for milk for the year ending October 1, 1929, was 170, while that for the year ending October 1, 1933, was only 150.

Breed.	1928-29		1932-33	
	Number of cows	Average yield	Number of cows	Average yield
		lb.		lb.
Ayrshire . . .	1,430	7,334	2,172	7,236
Friesian . . .	12,170	8,383	12,886	8,828
Guernsey . .	3,702	6,344	5,341	6,453
Jersey . . .	2,512	6,250	3,123	6,307
Lincoln Red . .	1,561	7,123	1,085	7,248
Red Poll . .	3,000	7,017	3,723	7,176
Shorthorn . .	45,391	6,986	41,670	6,989
South Devon . .	1,000	6,747	1,076	6,420

It is also argued that since this annual improvement is so small we ought to scrap existing methods of improvement. Apart from the fact that such critics are unable to put anything in place of that which they decry, it can be questioned whether the rate of improvement is slow.

Looking at the question from a genetic aspect, the point is complicated. The speed at which the genetic improvement of any species takes place *should be measured in generations, not years*, and in relation to the number of genetic factors that effect the characteristic in question.

If it is desired to fix a breed whose only desirable qualifications are the absence of horns, a black skin and a white face, it would take at least six generations before these three qualities would be even approximately fixed, and even then off types would be produced in comparatively large numbers.

Milk yield is inherited in a far more complicated manner than is coat colour. If, after six generations of intelligent selection for coat colour, we are still apt to get off types, so shall we be apt to get, for a much longer period, cows of low milk production that must be culled from our herds. *The science of genetics offers no short cut towards the improvement of our live-stock.* It justifies the methods of our master breeders, points to practices and beliefs that should be discarded, and by emphasis on the association of certain characters in their inheritance can certainly hasten the improvement of our stock. It cannot, however, substitute a quack medicine for the hard work and shrewd judgment that have characterized our master breeders of the past, and that will be as much required of their descendants in the future.

The science of genetics has already served a useful purpose in that our knowledge is being placed on a logical basis, whereby each new generation of breeders does not have to master the art from the beginning, but can make a start where its forerunners have ceased. As science codifies the laws of the inheritance of milk yield, so does it definitely assist the improvement of our average stock.

TYPE COUNTS—EVEN IN DAIRY CATTLE

BY

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(Reprinted from *The Farmer and Stock-Breeder*, Vol. XLVIII, October 22, 1934.)

NO QUESTION OF VALUE OF PROVEN SIRE—BUT THE PROGENY TEST IS NO SHORT CUT TO PERFECTION

Once you grant that the dual-purpose animal fits a certain type of farm economy then you must grant that conformation is of value in the selection of breeding stock. They are congenital idiots who decry the value of selection by the eye as a means for the improvement of dual-purpose cattle.

It is probably true that there is nothing we can *measure* which will give us an indication of the amount of milk a cow may give in a lactation. We know that, other things being equal, the bigger the cow the more milk she will give, and that the same applies to certain other qualities such as length, girth, etc. Mr. F. H. Garner, of Cambridge University, has recently shown that the larger the diameter of the milk veins the more milk will the cow give Especially as regards the heifer, there is nothing we can measure which will indicate future yield. That is about the sum of our scientific knowledge, which is mostly negative.

Every man who has done any real work with cattle, whether he calls himself scientist or farmer, knows perfectly well that the cow has certain points which indicate productivity. The mammary apparatus has not yet been scientifically measured, but its value can be roughly assessed by the man who knows dairy cattle. Few persons—if any—can distinguish between cows capable of yielding 400 lb. butterfat and those capable of producing 600 lb. or more, since both classes of cows do in all probability, possess similar external evidences of good dairy type. Let us remember that the yield of a cow in one lactation is only part of her total productivity.

In this connection Mr. James Wyllie's remarks about the " tin god of high yield " also hold good. A remarkable record achieved by a cow in a single lactation is not a sure criterion of her worth. There are two others which must also be taken into consideration. The first is the amount of food a cow eats per gallon of milk she produces. If the high yield is achieved by a greedy cow or by a cow who requires a lot of carrots or spice in her ration, she may well be uneconomic. One greedy cow at our experimental farm takes nearly ¾ lb. more food per gallon of milk produced than does her neighbour in the next stall.

Value of longevity.—The other point is longevity. It is not what the cow produces in one lactation that matters so much as what she produces in her lifetime. It is the cow that produces 10,000 gallons in her lifetime that really counts, not the cow that produces 2,000 gallons in one lactation. True, the last-named has a good start—if she keeps it up.

We must recognise that in breeding for high production we are selecting for a type that puts a heavy strain on the other organs of the body. The qualities that make for long life are multitudinous. Amongst the most important are the legs and feet. Crooked hind legs, poor pasterns, and soft hooves are causes of serious loss in our dairy herds, and are definitely hereditary. Bad hind legs reduce the value of a 2,000-galloner by at least 50 per cent. A cow with correct hind legs and hooves can live on concrete for fifteen years. The legs of a cow are every bit as important as the legs of the horse.

The all-round view.—The shape of the udder is also of importance. There are good producers with capacious but badly shaped udders which are liable to injury. Each quarter should be evenly developed, and the udder should not be pendulous or cut up. The well-built udder is protected from injury. But why go on ?

At the Dairy Show at Islington this week we can see for ourselves the type of cow that is wanted. We may not entirely agree with the judges, but then we may be wrong. It is quite correct that what we see at the Dairy Show, the types of the cows and their records of milk for a period of two days, does not give the real value of the animal. But then neither do the records published annually. Each gives a view of the cow from a different angle.

To get an all-round view we must consider many things. It is difficult to know on what point to lay the greater stress. At one time one point—such as the total lactation yield—receives greater emphasis, and this is followed by a swing of the pendulum for type. We can afford to neglect no aspect. Neither can we afford to over-emphasise any. The breeding of dairy cows is not a " stunt " ; it is the life work of a man who loves cattle.

At the present moment there is a definite tendency to ignore type. There will be many persons at the Dairy Show who, as they look round the cattle, will say, " What is the use of all this ? What really matters is milk." Type definitely has a value. No good horse ever was a bad colour, and no 10,000-gallon cow has ever had a bad tail head.

But even for fancy points there is some justification—provided these are kept in a subordinate position. The true breeder is an artist, and so long as this enjoyment of art is not the chief end, then none can criticise. Talking of criticism, thoughtful farmers will note that this criticism of type of dairy cows not infrequently comes from the man who himself has failed at the breeding of pedigree dairy cattle.

One last word about the progeny test. For the pedigree dairy breeder—and particularly those who lead the breed—there can be no question of the value of the sire who is proven to be good by both the yield and the type of his daughters.

Limitations of proven sire.—But for the commercial breeder—whether or not his stock is pedigreed—the use of an aged bull is fraught with difficulty. The emphasis at present being laid on the proven sire is justified, for there has been a tendency to neglect his value. Certainly we have been inclined to forget the work of some early breeders whom the present generation could teach nothing concerning the progeny test.

For the commercial breeder with the herd of modest size, however, the proven sire is a counsel of perfection. And even the proven sire needs to be selected. We must not let the present agitation blind us to the value of pedigree combined with the production records of the immediate ancestors. And in the selection of the dairy bull nothing can ever replace the records and the type of the dam of the bull.

Breeding dairy cattle is a difficult business, because the bull wont give milk. Dealing with the chances of heredity is a gamble, and always will be gamble. But if you apply skill, knowledge, and common sense it is a gamble with the odds in your favour. As science gets to work the odds will gradually be increased in the favour of the breeder. But do not let us expect any revolutionary short cuts. In the meantime nothing is likely to supplant hard work and shrewd judgment as the prime requisites of the breeder of dairy cattle.

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IN-BREEDING FOR PRODUCTION

BY

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(Reprinted from *The Ayrshire Cattle Society Journal*, Vol. 6, No. 3, September 1934.)

"Type has no value." But what is production? Production is the outcome of yield and quality of milk *plus* type. The production of a dairy cow cannot be measured merely by the yield of one or two lactations. The production of a dairy cow ends only with her death. Thus, until she is dead, what a cow has produced cannot be properly assessed.

Some cows do not give milk because they have not got the machinery inside them for the production of milk. Other cows do not give milk because although they have the machinery for the conversion of food into milk, they lack stamina or their legs break down, or their udder plays them false. Of course, even in the best regulated herds, accidents are liable to happen. Sheer accident, or disease can spoil the best cow in the world. Indeed, both accident and disease have spoiled many good cows.

To get their type, the early creators of our beef cattle deliberately in-bred. At varying intervals, this practice has been carried on by some of their successors. In-breeding has undoubtedly been shown to be a useful method for the production of the desired type. It is, of course, unnecessary for me to point out to Ayrshire breeders that mere in-breeding by itself will not produce the desired type.

If you in-bred to any old animal of any old type, then you will certainly not get the ideal conformation. In-breeding must be made to animals of the desired type. Even then it is not necessarily successful unless the foundation stock possesses the desired type to a high degree of excellence and is, what we might call, "pure" in its hereditary mechanism for that type. "Homozygous" is the ideal which the geneticists desire.

The United States Department of Agriculture have carried out an interesting experiment on the in-breeding of dairy cattle. In 1912 sixteen cows of mixed breeding were purchased. These were of average production and showed traces of Shorthorn, Angus, Hereford and Jersey breeding. A well-bred Guernsey bull was purchased to mate with these. This bull was mated to his own daughters out of these cows then to his own grand-daughters which were also his daughters.

A number of deformed calves resulted from this mating of a Guernsey bull to his daughters. They were of a type which is fairly well known to scientists. Out of 48 calves, six showed this "bull-dog" deformity.

As regards the production of milk of these in-bred Guernsey cows, it was found that the yields of the first generation daughters were practically the same as those of their dams, though the butterfat yield was a little bit higher. These daughters were the out-bred daughters of the Guernsey bull. Mated back to their sire, the Guernsey bull, the average production of the daughters remained about the same, while the butterfat showed a further, though small, increase.

In the year 1913 the authorities realised that the results of any experiment of this nature would depend largely upon the individuality of the bull used. Accordingly, *to the same foundation cows* they mated in that year a bull of the Holstein-Friesian breed. This bull was mated to his daughters and to his grand-daughters. A son of this bull mated to his grand-daughters was then used in the herd. More recently a son of this second bull has been used in the herd, while the bull at present in use is the result of mating the bull No. 3 back to his own dam.

From 1926—1931, 104 calves were born, of which 89 were in-bred and 15 were out-bred. All the out-bred calves were normal. Of the in-bred calves, four were carried full time but were born dead, one foetus was mummified, and there were three abortions (not infectious). Thus 9 per cent of the gestations of the in-bred animals ended abnormally. Comparable figures form the pure-bred Holstein-Friesian herd, carried on under the same management, gave 11 per cent of the gestations as terminating abnormally. It can thus be said that there is little difference in breeding efficiency between the in-bred herd and the other cattle on the same farm.

During the whole twenty years of this in-breeding experiment, only one deformed calf was born as a result of mating sire No. 1 to his own daughters, and this was not the same deformity as that which affected the in-bred Guernseys.

Coming now to the question of milk production of these daughters, grand-daughters and great-grand-daughters of the Friesian bull, we find that the first generation daughters showed an increase on their grade dams of roughly 400 gallons of milk and 70 lb. of butterfat. These daughters were, of course, out-bred. Mated back to their sire the grand-daughters, which were in-bred, showed a further increase of 100 gallons in yield, though only 5 lb. in butterfat.

Similarly the daughters of the other sires have shown small increases in yield. A fairly large population of daughters of Sire No. 2 (who was himself in-bred) mated to the in-bred progeny of Sire No. 1 showed an increase on the figures of the foundation cows amounting to some 660 gallons of milk and 100 lb. of butterfat. At that point, further increase seems to have been arrested.

This experiment shows that bull proved to possess an inheritance for a high level of milk production, brought about a big increase in production in the first generation daughters. Subsequent improvement through in-breeding was slow but definite. Unless in-breeding takes place to an animal of proved value, it cannot be expected to be successful.

There are one or two Ayrshire herds where in-breeding is being practised with undoubted success as regards the fixing both of type and milk yield. Such herds produce animals which are remarkably uniform in their production, both as regards type and milk yield.

No breeder of pedigree stock can afford to ignore the lessons from other breeds. Hence, rather than illustrate the lesson from herds concerning which Ayrshire breeders already know a fair amount, I will illustrate this point from the Lund herd of British Friesians belonging to Mr. C. W. H. Glossop, M. P.

The Lund herd was founded in the early part of 1922. Later in that year two unrelated calves were imported from South Africa. The one, a bull, was used as the first herd sire and was mated to the other, which was a heifer. This mating produced the second herd sire, and later on produced a heifer. The imported heifer was mated to an unrelated bull and thus produced the third herd sire who was then mated to the daughter of the imported heifer (that is to say, to his own half-sister out of the same cow) and produced the fourth sire. The fifth herd sire (at present in use in the herd) is the son of the second sire and out of one of the original foundation females of the herd.

Mr. Glossop's practice has been to use each successive bull on his half-sisters and frequently on his aunts, the dam of his half-sisters. The present herd sire is being mated with all the females in the herd and his progeny are accordingly very closely line-bred on both the sire's and the dam's side of their pedigree.

Despite this close in-breeding, Mr. Glossop has been able to record a wonderful success both as regards the maintenance of constitution and as regard milk production and quality. The dams of the five herd sires gave milk with an average fat-content of 4·09, 5·10, 5·10, 3·68, and 4·28 respectively. During the last 11 years, the herd has averaged 1,151 gallons of milk with an average of 3·70 per cent butterfat.

An inspection of the herd reveals the close-likeness between individuals. That type has not been lost in the process is revealed by the fact that, since the foundation of this herd some 12 years ago, it has won six Supreme Championships, eleven Championships, seven Reserve Championships, 20 First Prizes, 21 Second Prizes, and 26 Third Prizes. Moreover, the herd is not a large one, containing as it does only 35 animals.

As a means for the improvement of live-stock, in-breeding is one of the most important weapons which a beeder can employ. First and last, the success of in-breeding depends upon the quality of the foundation stock. This quality must be good in two respects—in respect of productivity (yield of milk and butterfat in the case of dairy cows) and also in respect of constitution. Furthermore, the quality of the foundation stock must be good, not merely so far as the eye can judge, but it must be absolutely sound as regards the hereditary mechanism.

The hereditary constitution of an animal can only be judged by the stock that it produces. By mating two closely related animals together, we can the more assurely obtain an indication of their hereditary constitution.

By in-breeding plus selection we can concentrate the desired qualities. This leads to prepotency.

As the productive qualities are enhanced and the yield of milk is increased, greater demands are made upon the other structures of the body. Merely to attempt to increase the yield of milk without giving the corresponding feed for the extra gallons, is obviously foolish. The extra gallons require more than dairy cake. Unless other demands such as the supply of minerals, etc., are also adequately met, it may be impossible to find out the true results of constructive breeding. Breeding and feeding go hand in hand.

As we get a better understanding of the nutritional requirements of the dairy cow, so we can modify the type by selective breeding methods. Correspondingly, as we improve the hereditary productive qualities of the cow, so we must pay particular attention to her feeding in order to ensure that her nutrition is adequate to express her hereditary possibilities. A policey of in-breeding concentrates more quickly the hereditary qualities of the herd. Accordingly an advance in breeding methods demands that full attention be paid to the adequate and balanced nutrition of the cows. Otherwise the hereditary effect may be completely masked.

Finally, one word of caution · in-breeding has been described as a two-edged sword. It is two-edged in that, unless the foundation stock are very good and are free from hidden defects, the practice of in-breeding will lead to grave disappointments. The fundamental difficulty is that until you in-breed, you cannot be sure of the hereditary constitution of your stock. Thus, in-breeding is somewhat of a gamble. It is not a practice which should be ordinarily adopted by the small breeder. Its success depends upon the quality of the foundation stock and also upon how far the breeder is willing to put his hand into his pocket in case it is not successful, if, at any time, any Ayrshire breeder is considering the question of in-breeding, we in this Institute will be willing to give what assistance we can.

SCIENTIFIC RESEARCH IN INDUSTRY

The following are extracts from a summary of the Report of the Department of Scientific and Industrial Research for the year 1933-34 (Cmd. 4787. Published by H. M. Stationery Office. Price 3*s.* net):—

Research associations

During the year the Advisory Council have discussed with more than half of the co-operative industrial research associations in receipt of grant aid plans for extending their scales of operations and have recommended substantial grants for a period of years. These offers are conditional upon increased industrial support. "The Council are confident", the Report states, "that the arrangements proposed will give the associations increased stability and increased opportunities for further expansion".

Other co-operation with industry

The Report refers to the encouraging growth in the volume of researches carried out in the Laboratories of the Department with the co-operation of industry. In these researches a large part of the cost is provided by contributions made by co-operating firms, either directly or through some industrial organisation, and the balance of the cost is borne by public funds.

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Food

The work carried out by the Department aims at benefiting the home consumer and home grower. The Report records however that the Dominions and Colonial Empire are now making contributions amounting to nearly £10,000 a year towards the maintenance of researches of special interest to them in this branch of the Department's activities. At the Covent Garden Laboratory there is a full-time officer experienced in examining experimental consignments of fruit and vegetables sent to this country. His services are available for Dominion and Colonial Governments.

A new method of cooling ships' holds, which offers economies in space and equipment and is suitable for a wide range of cargoes, has been devised, and is being adopted in some of the new tonnage now under construction for the Australasian trade.

APPLES, FISH AND MEAT

The capacity of commercial stores for home-grown apples, based on the Department's work on gas storage, is now estimated at 7,000 tons. A storage atmosphere has been worked out in which the characteristic flavour of Cox's orange pippin apples can be retained after six months' storage.

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WHAT MAKES GOOD BREAD

In another direction, interesting work is reported by the Flour Millers' Research Association, who are applying science to the baker's art, and are seeking an answer to the question " Why does one flour from one kind of wheat produce better bread and dough than another ". It is suggested that the reason this question has not been answered before, is due to the problem having been regarded as a chemical problem, whereas it is really a problem of physics.

" During fermentation ", the Report states, " a dough assumes a sponge-like structure, the individual cells increasing in size owing to the pressure of gas generated within them by the yeast. The cell walls are consequently in a state of varying strain, and it is their behaviour when in this condition (for example, whether they rupture easily or whether they stretch without rupture) that largely determines the quality of the resultant bread..............Little progress in our knowledge of flour quality is possible until the individual physical properties of dough which collectively make up quality can be measured ".

Strangely enough, methods for measuring the plastic and elastic properties of dough are being sought in the methods developed in the study of soil science, since similar properties are among the factors necessary in the top layers of cultivated soil.

On the chemical side it is pointed out that it is the carbon dioxide gas continuously produced in the dough by the action of yeast which causes the sponge-like nature of bread crumb.

" Flours from different wheats ", the Report states, " vary widely in their gassing power from poor to over-abundant. An inadequate 'gasser' can be converted into a satisfactory one by various methods ; either by incorporating some sprouted or frosted wheat (which are always good gassers) in the wheat mixture used for milling, or by adding highly diàstatic malt extract or malt flour to the flour. It has been discovered in the Research Association's laboratories that the method of milling is no less important than wheat variety in determining gassing power, and may be possibly even more important. The problem of bringing this important flour characteristic completely under the control of the miller during milling operations is well on the way to solution ".

NEW INSTRUMENTS AND METHODS

At the National Physical Laboratory, cinematograph films recording the movement of the top of the mercury column in mercury glass thermometers have indicated means for improving these instruments.

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Experiments with an "artificial eye" in the form of a photo-electric cell are being made in connection with the development of an industrial instrument for colour measurements and colour matching.

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COTTON

The Report affords ample evidence of the increasing interest displayed by the cotton industry in research. When the new experimental spinning rooms of the Cotton Research Association were opened in 1930, many members of the Association said that the accommodation was far more than could ever be utilised. Now, after only four years, the Report points out that insufficient space is available for the machinery required to deal with the numerous problems which arise, such as spinning tests on Empire-grown cotton and the preparation of special yarns for research purposes. During the year more special problems of individual spinners, manufacturers and finishers have been submitted to the Association for solution than in any previous year.

"In the face of this almost embarrassing recognition of the value of the Association to the trade", the Report states, "the difficulty of maintaining and extending fundamental research work has become even more acute than it was a year ago, but at the moment of writing there is happily every hope of increased financial support, which should justify the Institute in developing and extending the research work—now long overdue—on many fundamental problems".

WOOL

"The Association's new process for producing unshrinkable wool, yarns and fabrics, claimed to withstand the rigours of laundering, is being exploited under mill conditions. It is hoped to have materials available for the public early in 1935".

New fabrics specially suitable for motor-car upholstery have been made from wool and rubber latex. A considerable advance has been made in the protection of clothing, etc., against moths and mildew. Some of the results are applicable not only in mill practice, but also in the household. The protection of furs under storage conditions has also been successfully accomplished.

Work on the fastness of dyed fabrics to light and laundering has been completed, and definite standards of fastness to these agencies are now available.

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Research on roads

The Road Research Station of the Department is investigating the way in which variations of the physical properties of sub-soils, such as changes in the amount of moisture in them, interfere with their properties as road foundations. Comparisons are to be made between roads of similar construction carrying the same amount of traffic built on different sub-soils. Concrete and other materials for road construction are being studied in detail. The forces applied to roads by vehicles with different tyre equipment, wheel load, size of wheel, type of springing, unsprung weight, and with various inflation pressures of pneumatic tyres, are being measured. Steps are being taken towards developing a machine which will produce the same effect on model road sections in days as against years of normal wear. Two experimental machines with track diameters of 5½ ft. and 38 ft. for tests on the durability of roads are already in use while a third machine with a track of 110 ft. diameter is being designed. A special 16-wheel apparatus for measuring the development of surface irregularities which limit the life of roads, is being employed with these machines. Measurements of the blows imparted to roads by moving vehicles are being made with a recording apparatus fixed to the rear axle of a 6-wheel lorry. Liability to skidding is being investigated by a special form of motor-cycle and sidecar, but other methods of measuring skidding and side-slipping on road surfaces are under consideration.

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A COMPARISON OF THE FEEDING VALUES OF GRASS ENSILED BY THE A. I. V.-PROCESS AND A RATION CONTAINING MANGOLDS AND HAY

BY

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(Reprinted from *The Empire Journal of Experimental Agriculture*, Vol. III, No. 10, April 1935.)

This trial was carried out at the Old Parsonage Farm of Dartington Hall, Ltd., Totnes, S. Devon, and forms one of a series of A. I. V.-fodder trials sponsored by Imperial Chemical Industries, Ltd.

On September 15 and 16, 1932, about 10 tons of grass aftermath were ensiled. The herbage was chiefly cocksfoot and timothy containing small proportions of clover, perennial rye-grass, and members of the *Poa* family. It was mature and inclined to be stemmy.

The silo was a circular wooden pit, 9 ft. 9 in. diameter and 5 ft. high, sunk into the ground 1 ft. 6 in. with the sides banked with earth. It was not possible to sink the silo further owing to springs and downhill drainage-water which might seep into the pit. A catchpit filled with stones was dug in the centre and from it tile drains were laid to the hedge in order to carry off effluent in the early stages of compression.

The weather was dry and dull with sunny intervals, and the grass when cut had a normal moisture-content of 21·07 per cent. It was forked into the silo and the acid (standard A. I. V.-solution, consisting of a mixture of hydrochloric and sulphuric acids of 2N strength) was sprayed on continuously with a semi-rotary pump, at the rate of 20 gallons per ton. Composite samples of grass were taken during the two days of filling. When the wooden silo was filled, an over-silo of the same diameter and 6 ft. 6 in. high was put on and charging was continued until it was full. The top layers were sprayed with 'Homesurma' to inhibit mould, and a layer of nitro-chalk bags was laid over them. On these were placed a inch layer of wet sawdust, followed by a loose cover of flat wooden boards, more 4-sawdust, and finally 3½ tons of rock. The drain-opening was stopped up temporarily with a piece of sacking, which was removed after four days. There was a free flow of dark brown liquid for two or three days, and the drain was again closed after this had ceased. Analytical figures are given below.

The fodder had sunk below the level of the upper section by September 29, and this was removed and the top of the silo banked over with earth.

On November 22 the silo was opened. There were slight traces of mould at the sides and the top inch-layer of fodder was blackened and unusable. The colour of the bulk was brownish-green and the smell sharp and pleasant. The quality was even throughout the mass. The pH value was 3·5. Samples were taken for analysis at intervals during the emptying of the silo and the results are given in Table I together with the analyses of the original grass.

It will be noted that the ratio of digestible protein to crude protein, both in the original grass and the resulting A. I. V.-fodder, is very low and that the percentage of fibre is high. This is due to the maturity of the grass. A slight loss of crude protein has taken place in the lower part of the silo, but the ratio of true and crude protein has not been altered. The percentage of fibre in the A. I. V.-fodder is slightly greater than in the grass. There has been a loss of ash constituents by drainage from the lower part of the silo, though the volume of effluent was not great.

Table I

	Grass			A. I. V.-fodder: Date of sampling				
	Sample 1	Sample 2	Average	22nd Nov. 1932	29th Dec. 1932	17th Jan. 1933	27th Jan. 1933	Average
Crude protein	13·75	13·13	13·44	13·33	13·26	12·41	12·03	12·76
True protein (Stutzer).	10·31	10·94	10·63	10·97	9·31	11·16	10·00	10·36
Pepsin-HCl soluble protein.	4·94	4·97	4·96	5·27	5·97	7·73	5·94	6·23
Ratio of true protein to crude protein.	0·75	0·83	0·79	0·82	0·70	0·90	0·83	0·81
Ratio of digestible protein to crude protein.	0·359	0·379	0·369	0·395	0·450	0·623	0·494	0·491
Ash	9·23	8·64	8·94	8·77	9·61	6·68	7·13	8·05
Phosphoric acid P_2O_5.	0·63	0·59	0·61	0·53	0·58	0·39	0·35	0·46
Fibre	27·63	28·46	28·05	29·00	27·34	29·46	31·57	29·34
CaO	1·05	0·94	1·00	0·93	0·94	0·85	0·65	0·84
Ether extract	4·07	4·20	4·14	4·22	3·71	4·31	3·70	3·48
Moisture	77·08	80·77	78·93	79·58	81·86	86·21	81·75	82·34
Dry matter	22·92	19·23	21·07	20·45	18·14	13·79	18·25	17·66
pH	...	...	...	3·7	...	3·5	3·5	...

Virtanen (1) gives the following figures for protein in timothy grass and A. I. V.-fodder made from it.

	Dry matter	Crude protein in D. M. per cent	True protein per cent	Ratio of true to crude protein
Fresh grass . .	21·8	14·8	12·4	0·84
A. I. V.-fodder .	21·0	14·6	12·0	0·82

These figures are the average of determinations on six samples of fresh grass and on twelve samples of silage, and are for pure strains of grass, whereas the timothy grass used here was in a mixed herbage. It will be seen that the moisture losses were less than in the experiment carried out here, and that the percentages of crude and true protein were considerably higher, which is no doubt accounted for by the stemminess of our grass. On the other hand the ratio of true to crude protein has been maintained at the same level.

A sample of effluent from the silo was taken and contained nitrogen equivalent to 0·41 per cent crude protein, which agrees with the figure given by Virtanen (2) for clover silage. Watson (3) obtained a mean figure of 2·15 per cent for the drainage liquid from young grass ensiled in the ordinary manner, whereas Boyle and Ryan (4) found 1·6 per cent. Unfortunately, no measure of the amount of liquid flowing was obtained, so that the above figures are not strictly comparable and no estimation of the actual weights of protein lost can be made.

The claims which have been made on behalf of A. I. V.-fodder have to some extent been investigated under experimental conditions in Great Britain with regard both to the preservation of the essential food-value of the herbage and also the palatability and feeding qualities for dairy cattle. The present investigation was undertaken in order to extend the scope of a series of further experiments undertaken by Imperial Chemical Industries, Ltd., to practical farming conditions, with the maximum of scientific control.

It cannot be too strongly emphasized that in work upon dairy cattle it is impossible to obtain at one and the same time the strict statistical design which is scientifically desirable together with the practical farming conditions which alone can answer the question of the suitability of the method for application to the industry. Without the former the pure scientist will be unconvinced by the result, whilst the most carefully designed investigation which interferes with farming practice will fail to convince the working farmer.

A few points in the present feeding-trial are worthy of note as illustrating this point. The number of cows that could be used was limited to the herd of 55, which, as in most dairy herds, contained few full sisters, since the average number of lactations is rather under four, producing usually a total of two heifer calves. These sister cows would of course never be in the same lactation-period. If cows of a similar type which are half-sisters or unrelated are taken, it is extremely difficult to match two beasts at the same stage of lactation without keeping the cows dry for a period in order to get them into calf at the same time, a proceeding which would not be sound farming practice and which would undoubtedly vitiate the result in the eyes of the farmer. It would also affect the scientific accuracy of the experiment owing to the fact that little is known of the accumulation of reserves in a cow during a dry period. It is hardly necessary to point out that to match cows in different parts of the lactation-period is extremely unsound. Finally, in order to match pairs of cows, arrangements must be made long in advance—the difficulty of which is well known to any one familiar with the management of a dairy herd—in order that they may become accustomed to adjacent stalls. The drop in milk-yield following a complete reshuffling of the herd immediately prior to the experimental period would be sufficient to wreck the experiment completely.

It was decided, therefore, that to attempt to claim the use of similar pairs of cows in the experiment would be unjust and misleading. Instead, one row of the four in the cow-house, each containing 13-15 representative beasts, was selected by the farmer, and the feeding-trial was carried out with an experimental group on the period-reversal system in December, 1932, and January and February, 1933. The cows had been indoors since October and had not been moved from their stalls. The breed was pedigree Dairy South Devon.

The cows covered a wide range of ages and periods in lactation, and all had been in milk at least one month before the trial began. The cows were weighed before the first period and at the end of the first and each succeeding period. Milk records were kept for each cow weekly, and determinations of the butter fat content of the milk were made. During the last week of each period butter was made from the bulked milk and the yellow colour determined by the Lovibond tintometer.

Before the feeding-trial began three cows, not included in the experimental group, were fed for several days with A. I. V.-fodder to ensure that no taint could be communicated to the milk.

Each period of the trial was five weeks long, and during the first and third periods each cow received a normal winter ration of hay, mangolds, and concentrates as fed to the whole herd. During the second period the mangolds and part of the hay were replaced by A. I. V.-fodder. Assuming a starch equivalent for the

fodder of 10 per cent and a protein equivalent of 1·04 per cent, 40 lb. of A. I. V.-fodder replaced 40 lb. roots and 5 lb. hay. Thus :

	Dry matter lb.	Starch equivalent lb.	Digestible protein lb.
40 lb. A. I. V.-fodder . .	8·00	4·0	0·42
40 lb. Mangolds . .	5·28	2·80	0·16
5 lb. Hay	4·30	1·55	0·23
Total .	9·58	4·35	0·39

It was unfortunate that the low digestible protein value made it impossible to replace any of the concentrates.

The maintenance ration for a South Devon dairy cow weighing about 1,400 lb. is 7·6 lb. starch equivalent, *plus* 0·86 lb. protein equivalent. Hay was fed in addition on a reducing scale according to the milk yield, from 25 lb. for a 2 and 3-gallon cow to 5 lb. for a 7-gallon cow. Typical rations for a 3-gallon cow are given in Table II.

TABLE II

	Periods 1 and 3				Period 2			
	Weight lb.	D. M. lb.	S. E. lb.	P. E. lb.	Weight lb.	D. M. lb.	S. E. lb.	P. E. lb.
Hay . .	21	18·0	6·51	0·97	16	14·0	4·96	0·73
Mangolds .	40	5·3	2·80	0·16	..	..	..	..
A. I. V.-fodder	..	..	..	..	40	10·0	4·00	0·42
Concentrates	12	10·8	8·28	2·04	12	10·8	8·28	2·04
Total .	73	34·1	17·59	3·17	68	34·8	17·24	3·19

The composition of the concentrates is as follows :—

	lb.	D. M. lb.	S. E. lb.	P. E. lb.
Kernelin . .	2	1·80	1·60	0·40
Bran . . .	2	1·74	0·84	0·20
Maize meal . .	3	2·61	2·43	0·20
Bean meal . .	2	1·71	1·32	0·40
Decorticated ground-nuts.	2	1·79	1·46	0·82
Crushed oats . .	1	0·87	0·60	0·08
Total .	12	10·52	8·25	2·10

Of this mixture is fed per gallon :

lb.	D. M. lb.	S. E. lb.	P. E. lb
4	3·6	2·76	0·68

The younger cows took to the silage readily and ate with relish, but the older ones needed much persuasion and were never greatly interested. There was no scouring.

Milk yields were recorded weekly with the rest of the herd. Table III gives the calculated average weekly yields per cow and average rate of fall.

TABLE III

Period	Week	Average weekly yield in lb. per cow			Average rate of fall in lb. per cow per week			
		A. I. V.	Rest	Difference	A. I. V.		Rest	
Transition .	1	233·4	177·7	55·7	..		..	
I . .	2	221·4	173·9	47·5	—12·0	Mean —7·7	— 3·8	Mean —4·9
	3	222·5	171·7	50·8	+ 1·1		—2·2	
	4	211·7	162·6	39·1	—10·8		—9·1	
	5	202·7	158·0	44·7	—9·0		—4·6	
Transition .	6	179·0	143·7	25·3	—23·7		—14·3	
II . .	7	183·7	149·3	34·4	+4·7	Mean — 1·2	+5·6	Mean —3·5
	8	179·7	143·8	35·9	—4·0		— 5·5	
	9	182·0	136·8	45·2	+2·3		—7·0	
	10	174·2	129·8	44·4	—7·8		—7·0	
Transition .	11	168·8	125·7	43·1	—5·4		—4·1	
III . .	12	165·2	123·9	41·3	—3·6	Mean —4·4	—1·8	Mean — 3·0
	13	149·3	121·1	28·2	—15·9		—2·8	
	14	149·6	118·3	31·3	+0·3		—2·8	
	15	151·2	113·6	37·6	+1·6		—4·7	

These results are also given in graphical form, together with the mean temperature for the corresponding week (Fig. 1).

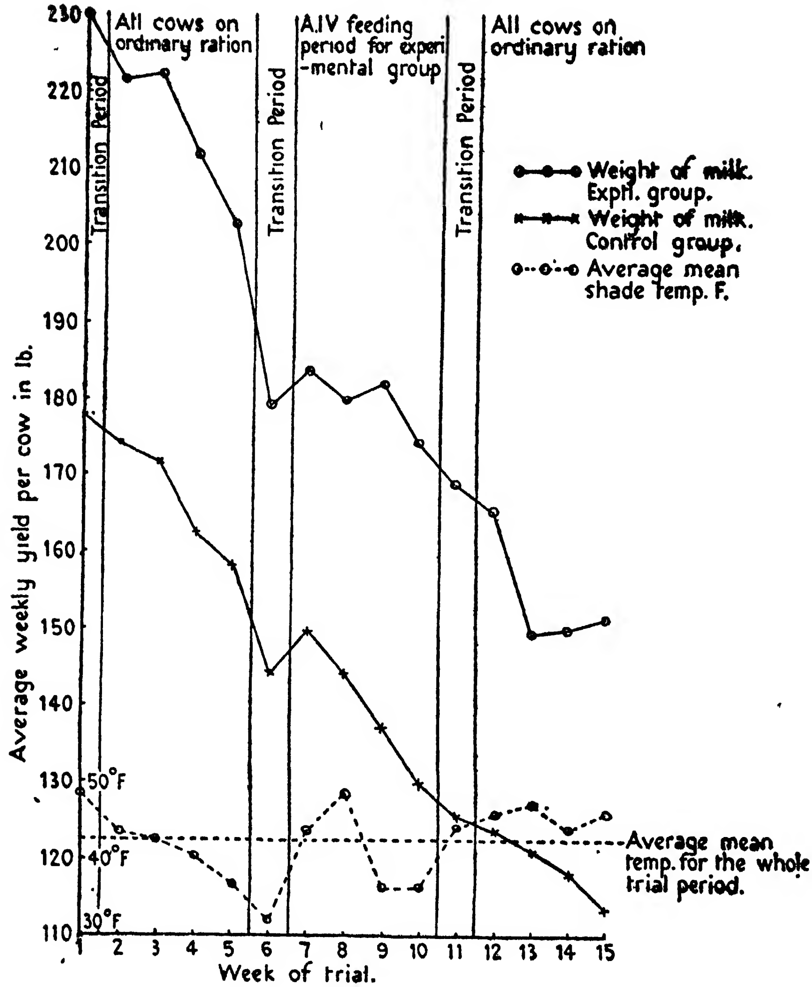

Fig. 1. Average weekly yield of milk per cow of cows fed on hay, mangolds, and concentrates and of cows fed on a ration in which A. I. V.-fodder partly replaced hay and mangolds. Average weekly shade temperatures during the trial.

It will be seen that there was a sudden decrease in the milk-yield on changing over to the A. I. V.-fodder. This was, no doubt, due to the unusual nature of the ration but the change also coincided with a sudden spell of very cold weather. During the actual period when A. I. V.-fodder was given the mean rate of fall was much less, and steadier, than during the first or the third period.

The decrease in milk-yield of the control group during the transition period was not as great as in the experimental group of cows. The cold spell evidently had a considerable share in the drop in yield of the experimental group, which was therefore only partly due to the change over to the A. I. V.-fodder. Further, the average rate of change during weeks 7 and 8 was in the same direction over the whole herd and of the same order.

The total average yields per cow during the trial for each of the four-week periods is given in Table IV.

TABLE IV

Period	Total average yield (lb.)	
	A. I. V.-group	Control group
I	858·3	666·2
II	719·6	536·1
III	615·3	470·5
Mean I and III	736·8	568·4
Difference from II	17·2	32·2
Equivalent to, per day	0·6	1·2

This estimated drop in yield during the A. I. V. feeding-period is 2·4 per cent for the experimental group and 6 per cent for the control group. It is not certain whether this is within the limits of experimental error and therefore no conclusion is drawn from it. It is unfortunate that the amount of silage made was insufficient for a longer feeding-trial, so that the transition periods could have been longer than a week.

Determinations of percentage butter fat were made weekly. Table V shows the average yield of butter fat per cow and the average fat-content of the milk

for each of the three periods. It will be seen that there was a slight but not significant increase in the fat-content of the milk when the cows were fed on A. I. V. fodder.

TABLE V

	Average yield of butter fat per cow lb.	Average fat-content of milk per cent
Period I	36·93	4·302
,, II	31·21	4·337
,, III	25·97	4·232
Average of periods I and III	31·45	4·267

Samples of butter were made from mixed milk of the group at the end of each feeding-period and the yellow colour was estimated by the Lovibond tintometer (5). The yellow colour during the A. I. V.-fodder feeding-period was more than double that in either of the other two periods. The butter produced during these control periods was the typical colourless produce of winter months:

Period	Lovibond yellow units
I	4·0
II	8·4
III	2·8

The consistency of the butter was also improved.

It has been shown (6) that the intensity of the yellow colour of butter is closely correlated with the vitamin A content for Shorthorn cows, and it is likely that this parallelism applies also to the South Devon breed.

Spectroscopic determinations of vitamin A, carotene, and xanthophyll were made at Liverpool by Prof. I. M. Heilborn (7) and showed that these values were proportional to the yellow colour of the butter.

The cows were weighed at the beginning of the trial and at the end of the feeding-period. Table VI gives the mean weights per cow.

TABLE VI

	Pre-trial period	End of period I	End of period II	End of period III
	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.	cwt. qr. lb.
Average weight per cow . . .	14 0 26	13 0 17	14 1 15	13 2 26

It will be seen that the average loss in weight of 1 cwt. per cow during period I was made up when A. I. V.-fodder was fed in period II, although the weight of dry matter in 40 lb. A. I. V.-fodder was 7 lb., as against 9½ dry matter in 40 lb. mangolds and 5 lb. hay. The digestible protein in the A. I. V.-fodder was only slightly greater than that of the mangolds and hay, and therefore the increase in weight in period II cannot be accounted for by any increase in weight of nutrient supplied.

It is suggested that that part of the fall in milk-yield, which could not be accounted for by the sudden cold spell during the transition period when the feeding of A. I. V.-fodder commenced, might have been prevented by a more gradual introduction of the fodder into the ration.

Conclusion.—The object of this paper is to answer the question : If A. I. V.-fodder is used to replace mangolds and part of the hay in a ration, what will be the effect on (1*a*) the quantity, (1*b*) the quality, of the milk, and (2) the cow ?

Briefly the answers are :

(1*a*) No change of agricultural significance.

(1*b*) Butter-fat content hardly affected, colour and vitamin-A content much improved.

(2) No scouring or ill effects. Eaten with relish by younger cows. Live-weight maintained.

It is not claimed that the fodder will have any startling effects on the condition or milk-yield of a herd, but that it may replace more expensive portions of a ration effectively, when used under normal farming conditions. It should, therefore, be of use to farmers as a means of conserving grass in difficult hay seasons, of making effective use of sudden flushes of grass or excess aftermath, of cutting out root-crops with their high labour costs, and of improving the quality and appearance of the milk, particularly during the winter months.

Summary

1. Mature aftermath grass was ensiled by the A. I. V.-process.

2. The analytical values for the fresh grass and the A. I. V.-fodder show that little change occurred in the content of protein, though the values for phosphoric acid and calcium are lower in the silage. No estimate of the losses can be made since the grass was not accurately weighed when filled into the silo and the total weight of A. I. V.-fodder is not known.

3. A feeding-trial was carried out with South Devon dairy cows on the period-reversal system; 40 lb. A. I. V.-fodder replaced 40 lb. mangolds and 5 lb. hay.

4. The milk-yield during the A. I. V.-fodder feeding-period fell by 1·2 lb. per cow per week compared with values of 7·7 lb. and 4·4 lb. during the preceding and following control periods. There was a pronounced fall during the transition period when the cows were being brought on to the A. I. V.-ration. This was only partly due to the change of ration, since the milk-yield of the rest of the herd fell sharply at the same time, due to a severe spell of cold weather.

5. The average percentage butter-fat was slightly, but not significantly, higher during A. I. V.-feeding: 4·34 per cent compared with an average of 4·27 per cent before and after.

6. The colour of the butter-fat was more than doubled during A. I. V.-feeding.

7. The live-weights of the cows fell during the control periods and rose to slightly above the initial weights during A. I. V.-feeding.

My thanks are due to Messrs. Imperial Chemical Industries, Ltd., Agricultural Research Station, Jealott's Hill, for the Lovibond tintometer determinations of the yellow colour of the butter, and for their co-operation in the conduct of this experiment; and to Mr. C. F. Nielsen, Manager of the Old Parsonage Farm, Dartington, for his assistance and co-operation in the feeding-trial.

REFERENCES.

1. A. I. Virtanen. Quoted in *Scottish J. Agric.*, 1932, **15**, 252.
2. — *Empire J. Expt. Agric.*, 1933, **1**, 143.
3. S. J. Watson. *J. Agric. Sci*, 1931, **21**, 425.
4. C. Boyle and J. J. Ryan. *Economic Proc. Royal Dublin Soc.*, 1933, **2**, 515.
5. S. J. Watson, G. Bishop, and J. C. Drummond. *Biochem. J.*, 1934, **28**, 1076.
6. S. J. Watson, J. C. Drummond, I. M. Heilbron, and R. A. Morton. *Empire J. Expt. Agric.*, 1933, **1**, 68.
7. A. E. Gillam and I. M. Heilbron. *Biochem. J.*, 1934, **28**, 1082.

RECENT RESEARCH IN POULTRY NUTRITION*

(Reprinted from *The Harper Adams Utility Poultry Journal*, Vol XX, No. 2)

The amount of experimental work on the feeding of poultry is now so large, and is scattered through such a wide variety of journals, that workers in the subject cannot but feel grateful to the Imperial Bureau of Animal Nutrition for this valuable monograph, in which many interesting features of recent research are fully discussed. Although its interest will be chiefly for the research worker, it will also be useful to students and others who wish to be up-to-date in their knowledge of progress in the application of research to the important problem of the efficient nutrition of the fowl.

The report deals first with some of the problems connected with chickens, then with adult fowls, and lastly with the incubation of eggs. "The practical bearing of experimental results has been borne in mind throughout but has not always been stressed, as it is often difficult to evaluate the significance of certain data from the point of view of the poultry husbandman."

A general idea of the character of the monograph and of some of the conclusions arrived at will be gained from the following Summaries taken from it. The section on 'Minerals' does not admit of concise summary but is referred to in the General Summary.

VITAMIN A

Summary.—The clinical appearance of chickens suffering from vitamin A deficiency is not very specific. The feathers are ruffled and "staring", and the birds seem hunched up. The high blood-uric acid is an aid in the diagnosis, but under practical conditions it is generally sufficient to take as a criterion the probable vitamin content of the ration. When yellow maize is over 25 per cent, when there is a good deal of alfalfa leaf meal (over 10 per cent in an otherwise vitamin A-poor ration) or at least 1·5 per cent of cod-liver oil, a deficiency of this vitamin is improbable. This is also the case when the birds have access to a good grass range. Under the conditions now prevailing in most countries, vitamin A deficiency has ceased to be a serious problem, at least for growing chickens.

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* A review of Imperial Bureau of Animal Nutrition Technical Communication No. 5, by A. R. G. Emslie, M.S.A., B.Sc. (price 1s.).

Vitamin D

Summary.—Without differentiating between rickets and other bone abnormalities which are prevented by vitamin D, it may be said that the general experience of investigators is that an inadequate supply of vitamin D to growing chickens will result in certain symptoms of malnutrition. Chief of these is the flexible state of the limb and breast bones and beaks. The limb and breast bones often become crooked. *Post mortem* examination will often, but not invariably, reveal a beaded condition of the ribs and enlargement of the parathyroids. The ash percentage of the leg bones is subnormal, and bone and plasma phosphatase values are high. Curative measures are generally very effective if commenced soon enough.

Prevention under commercial conditions can be done most simply, as in the case of chickens in battery brooders where it is inconvenient to allow the birds sunshine, by feeding 0·5-1 per cent of a good grade of cod-liver oil. The unrefined grades sold by reliable firms will probably be found sufficiently anti-rachitic; some authors, however, advise the use of tested grades as they consider the extra cost fully justified. When the chickens are exposed to direct sunlight, or to that transmitted by reliable glass substitutes, it is probable that only when the hours of sunlight are very short will it be necessary to add cod-liver oil to the ration. It should be remembered, however, that when the windows of the brooder house are of ordinary glass, "rickets" may develop even when the chickens have access to outside runs, as on certain types of rations it has been observed that all birds may not take advantage of the direct sunshine. The minimum requirements of vitamin D seem linked with the optimum amounts and the "availability" of Ca and P in the ration, so these should be considered. In regard to the use of irradiated ergosterol it would seem preferable to withhold definite judgment until further experiments have been carried out to study its relationship to the anti-rachitic factor for poultry. The use of the term "rickets" has been used too loosely in experiments with chickens for there to be sufficient proof as yet that investigators have been comparing only the anti-rachitic effect of cod-liver oil and irradiated ergosterol.

Vitamin B

Summary.—Even in this short discussion of some of the work on the vitamin B requirement of chickens it can be seen that there are many problems awaiting solution. There is considerable similarity in the symptoms credited to deficiency of the various factors, but unless detailed examinations and reports are available the matter must remain obscure. "Paralysis," or "leg weakness", for example, seems to be one of the commonest symptoms of ill-health in chickens: as a general rule, however, there is some peculiarity distinguishing the different types.

The factors which are definitely known to be required are B_1 and B_2. Deficiency of the former causes the well-known polyneuritic symptoms. Under practical conditions with the common cereal mashes used, and with the birds allowed outside on grass runs, vitamin B_1 deficiency seldom occurs. Green food or the milling products made from the outer layers of grains will prevent the symptoms appearing in birds kept in confinement. Yeast or yeast preparations are commonly used in laboratory work. The case with regard to vitamin B_2 deficiency is not so simple of diagnosis. Seldom does one get symptoms of pellagra under even intensive commercial conditions; it occurs only under fairly rigorous experimental control. Should the paralysis mentioned by Ringrose, *et ql*, be considered to be a symptom of vitamin B_2 deficiency, it would seem that many cereal diets contain insufficient amounts of the vitamin. The cure is probably simple enough—lessening of the vegetable protein in the diet if it be already very high, the giving of milk and, in severe cases, of marmite or other potent yeast preparations.

While realising that work on the other factor awaits confirmation, we may tentatively consider that both B_3 and B_4 are required. The paralysis described by Ringrose, *et al* and by Kline, *et al* was rather similar but apparently due to different causes: in the former case it was prevented by the use of autoclaved yeast, and in the latter by a factor which was destroyed by autoclaving.

"Leg weakness"

Summary.—In differentiating the numerous forms of "leg weakness" in chickens and adult fowls it is not always enough to consider the symptoms alone, as the early stages of many of the types are rather similar. A knowledge of the previous history of the birds as regards food and environment is of great value. Also, there may be a complication of two forms of "leg weakness" in the same flock, for instance the "slipped tendon" and the nutritional paralysis" types, as observed by Bethke, *et al.* As with other diseases, early diagnosis may be relatively simple: but where the ætiology of the disease has not been fully investigated, one may have to try different curative measures before arriving at the correct one.

There are at least seven types of "leg weakness" which are definitely due to dietary errors. Their prevalence varies in different localities. Those caused by relative deficiencies of the vitamins (A, B_1 and D) and of calcium, while met with fairly often under other than strict laboratory conditions, are quite easily cured and prevented. Excess of magnesium in the ration is not a very common occurrence in most places. The "slipped tendon" and "nutritional paralysis" types of "leg weakness" may occur rather unexpectedly and are perhaps less easy to rectify. For the former condition, decreasing the amount of bone meal in the ration and adding rice bran (if easily available) or oats or wheat germ middlings are remedies suggested by investigators. Dried yeast is becoming

quite a common ingredient in many poultry food mixtures, and should assist in preventing "nutritional paralysis". A better method may be to give the birds liquid skim-milk to drink, or to increase the amount of dried milk while decreasing some of the other protein concentrates in the ration.

As was pointed out at the beginning of this section, "leg weakness" in poultry is by no means a specific symptom. It is not suggested that the forms reviewed here are the only ones which may be encountered under experimental or even commercial conditions.

HATCHABILITY

Summary.—From the experiments reviewed in this section, the conclusion might be drawn that under conditions of confinement, birds kept for breeding probably require an animal protein supplement in their ration. There is considerable difference in the value of these: good grades of milk powders, fish meal and meat meal are probably better than tankage and those products which are treated to high temperatures in their manufacture. A mixture of supplements would seem to be an improvement upon any one alone, if there be no other limiting factors. It has to be remembered, of course, that in some of the experiments it is not necessarily the effect of the protein of the supplement, *qua* protein, which results in improvement of the hatchability of the eggs, but that one product may possess certain other qualities which are limiting factors in another supplement. When birds have access to good range, they appear able to make good many deficiencies connected with the type of protein supplement used.

Vitamin D deficiency is an important factor in causing poor hatchability, and can probably be supplied most efficiently at present, for birds in confinement, by fish-liver oils. The need for additional vitamin D is correspondingly less with increase in the amount and quality of sunshine available for the birds.

Of the environmental factors, good grass range is of no small importance in allowing the birds to supplement their dietary defects. This is probably one of the reasons why it is only fairly recently that large-scale experiments have been carried out in Great Britain on the effect of nutrition on hatchability.

The time an egg is laid may be a possible factor also. Hutt and Pilkey found that eggs laid before 9 A.M. hatched better than those laid after 12 noon, especially during the early part of the hatching season. They suggested that this might be related to chilling of the eggs at a critical stage in the development of the embryos, which stage had been passed by the embryos in eggs laid before 9 A.M. Nicolaides was unable to confirm the difference in hatchability between eggs laid before 9 A.M. and after 12 noon, but found from cytological studies that embryos in newly laid eggs from high hatching hens were further advanced in development than those in eggs from low hatching hens, regardless of the time of laying. Funk found that eggs laid in the afternoon hatched better than those laid in the morning, and during an extremely cold week there was a significant decrease in the hatch from eggs laid before 9 A.M.

Hale suggested that embryonic malposition might be related in part to incorrect incubation, the turning of the eggs and the angle at which they were placed in the incubator being important. The extensive work on the numerous malpositions and malformations of embryos is not reviewed here. Indications at present point to the effect of genetical and nutritional as well as environmental factors in preventing these abnormalities.

General summary

In this monograph are discussed some of the experiments dealing with six phases of poultry nutrition, *viz.*, "purified" diets; the vitamins; the minerals; "leg weakness"; mineral balance experiments and hatchability.

It appears possible to rear chickens to maturity with a fair degree of success on "purified" diets but it is as yet too early for one to say what are their exact nutritional requirements. Of the vitamins, A, D, and E appear most easily supplied in adequate amounts. At present it is not possible to state all the factors of the vitamin B complex which are necessary: vitamins B_1 and B_2 are most certainly required, B_4 very probably and B_3 possibly. The other factors of the complex necessary for normal growth have not yet been classified. Work on those minerals which are most likely to be present in sub-optimal or excessive amounts has been discussed, and the effect of these levels on the health of growing birds dealt with. Calcium and phosphorus metabolism is affected by the form in which they are fed as well as by the presence of vitamin D and of other elements in the ration. Discussion of "leg weakness" has taken place under the headings of those forms caused by micro-organism and those more intimately related to errors in the diet. The chief symptoms typical of the conditions have been outlined, together with what appear at present to be curative and preventive measures. The few experiments on record dealing with the retention of calcium and phosphorus have been reviewed. It would appear that a further study by means of balance experiments of the best forms in which to feed these elements and of the importance of vitamin D and of the other factors on their proper utilisation, should prove of value in the correct management of the flock under intensive conditions. The proper development of chicken embryos is affected by many things, not the least of which is the nutrition of the parents. In this connection factors of primary importance are the supply of vitamin D and the quantity and quality of the protein supplements. Analyses of eggs of high and low hatchability have not shown that the amino-acid N distribution is significantly different in the two cases, and it is not unlikely that some of the B vitamins are limiting factors.

ABSTRACTS

Helminthosporium diseases of barley and the methods of their control.

M. MITRA and R. D BOSE. (*Ind. J. Agric. Sci.* 5, 449.)

Three species of *Helminthosporium* occur on barley in India, *viz.*, *H. sativum* P. K. & B., *H. teres* Sacc. and *H. gramineum* Rabh., *H. sativum* is common at Pusa and its neighbourhood every year. It is responsible for 'foot-rot' and 'root-rot', head blight and spot formation in all aerial parts and does a good deal of damage to the crop. It lowers the percentage of seed germination. The affected plants are stunted and the leaves are discoloured, followed by the shrivelling up of the grain and a reduction in the yield. The fungus is seed borne and persists in the debris of affected plants in the soil. Wheat and some of the grasses are also affected by it.

H. teres also occurs in Pusa but is restricted to such types as have been introduced from outside. It is absent altogether on the local types of barley grown round about Pusa. *H. gramineum* is very rare in Pusa.

Investigations carried out at Pusa for the past five years have shown that environmental factors play an important part in the incidence of disease due to these two organisms and that the severity of the disease varies from field to field and even in the different parts of the same field. Varietal difference in the degree of attack on the different types was also noticed. Early varieties seemed to suffer less. The degree of attack varies from season to season.

The percentage of leaf area destroyed by *H. sativum* and *H. teres* in the various varieties was determined and in both the introduced and the Pusa varieties there are types which show considerable resistance to the disease.

Fungicidal dusts and liquids have been used to reduce the loss but none has so far been found to completely check the disease. While disease in the seedling stage has been controlled to some extent, it has not been possible to check secondary infection at heading time from the infective material already in the soil or from other hosts.

Since the disease, especially the secondary infection, cannot be effectively controlled by seed treatment alone, the necessity for evolving new types resistant to the disease becomes apparent. The use of existing resistant varieties and breeding of new types with more suitable agronomic characters is, therefore, one of the most promising methods of preventing *Helminthosporium* disease. This method is receiving the attention it deserves. In addition to breeding resistant varieties, it is advisable to plant clean seed and to have crop rotation in order to reduce the possibility of infection from the soil. (*Authors' abstract*).

Seedling blight of *Cinchona ledgeriana* Moens caused by *Phytophthora palmivora* Butl. in the Darjeeling district. K. F. KHESWALLA. (*Ind. J. Agric. Sci.* **5**, 485.)

A seedling blight of *Cinchona ledgeriana* Moens is caused by *Phytophthora palmivora* Butl.

The disease generally manifests itself at the collar and gradually extends upwards. Rotting of the affected tissues follows and the whole seedling is killed. The optimum temperature for growth of this organism is about 24°C. and the growth ceases at 35°C. Cross inoculations with cinchona *Phytophthora* and *P. palmivora* gave successful results. Morphological comparisons of cinchona *Phytophthora* with *P. palmivora* Butl., *P. meadii* McRae, *P. colocasiae* Rac. and *P. parasitica* Dast. indicate that it agrees most closely with *P. palmivora* Butl. Statistical comparison of the sizes of sporangia of cinchona *Phytophthora* and *P. palmivora* Butl. was made and it was found that in length the sporangia of both the fungi agree but in breadth the sporangia of the former are slightly narrower than those of the latter. It is, therefore, concluded that the cinchona *Phytophthora* is *P. palmivora* Butl. (*Author's abstract.*)

Studies on the root-rot disease of cotton in the Punjab. I. Symptoms, incidence and cause of the disease. R. SAHAI VASUDEVA. (*Ind. J. Agric. Sci.* **5**, 496.)

1. Cotton root-rot has been doing serious damage to both American and Desi (indigenous) cottons in the Punjab.

2. Symptoms of the disease are described.

3. The disease first appears in June and continues to be vigorous during July. In August the attack slows down and almost ceases by the end of September.

4. Several organisms were isolated from the diseased plants and inoculation experiments carried out in the pots as well as in the field by various methods. *Rhizoctonia solani* and another fungus which is provisionally called *Rhizoctonia bataticola* have been proved to be the casual organisms. (*Author's abstract*).

Studies in Indian chillies (4). Inheritance of pungency in *Capsicum annuum* L. RAMCHANDRA BALWANT DESHPANDE. (*Ind. J. Agric. Sci.* **5**, 513).

The paper deals with the inheritance of pungency of the chilli fruit in a cross between pungent and non-pungent Pusa types of chillies.

Pungency is found to be dominant to its allelomorph, non-pungency or sweetness, on a 3 : 1 monohybrid ratio, the F_3 confirming the F_2 observations. This character and the nature of calyx, enclosing or not enclosing fruit base, are found to segregate independently. (*Author's abstract.*)

Phyllody—a possible virus disease of sesamum. B. P. PAL and PUSHKAR NATH (*Ind. J. Agric. Sci.* **5**, 517).

Phyllody manifests itself in *Sesamum indicum* D. C. by the transformation of all floral parts, except the stamens, into leaf-like structures, by the replacement in the flower of zygomorphic symmetry by actinomorphic symmetry, by the development of the normally rudimentary fifth stamen, and, in the case of varieties which normally develop only one flower per axil, by the replacement of the glands present on either side of the flower by lateral flowers so that three flowers per axil are produced. There is also a shortening of the upper internodes and a reduction in size of the foliage leaves. The different kinds of phylloid flowers met with are briefly described.

Neither heavy manuring nor growing plants under artificially contrived conditions of high humidity sensibly increased the percentage of phylloid plants. It was observed, however, that early sowings contained a larger proportion of them than late sowings.

Although hypodermic injection of juice extracted from phylloid plants into the stems of normal plants gave negative results it was found possible to transmit the phylloid condition by grafting normal scions on phylloid stocks and *vice versa*. It is therefore suggested, although the evidence is not yet conclusive, that phyllody may be caused by a virus. (*Authors abstract*).

Studies in the technique of field experiments. I. Size, shape and arrangement of plots in cotton trials. J. B. HUTCHINSON and V. G. PANSE. (*Ind. J. Agric. Sci.* **5**, 523).

1. The results of a uniformity trial with Malvi cotton at Indore are reported.

2. Standard error per cent per plot decreased steadily with increasing plot size.

3. For any given plot size standard error per cent per plot decreased steadily as the length of the plot (along the rows) was increased.

4. The advantage of long, narrow plots laid out along the rows over plots of the same size and shape laid out across the rows is shown to be independent of fertility gradient, and it is suggested that it is associated with the method of sowing.

5. It is shown that approximately square blocks climate more of the soil heterogeneity than rectangular ones. With blocks of 1/25 acre or larger, shape is the most important factor in determining efficiency.

6. A Latin Square lay-out has no advantage over an efficiently designed randomised block lay-out with the same number of plots.

7. Optimum lay-out for different types of experiments are discussed and a table is given to facilitate determination of the amount of land and number of replications required for a given accuracy with different plot sizes. (*Authors' abstract.*)

Inheritance of characters in sorghum—the great millet. VII. Ligule and auricle. G. N. Rangaswami Ayyangar, V. Panduranga Rao and A. Kunhikoran Nambiar. (*Ind. J. Agric. Sci.* **5**, 539).

An e-ligulate and non-auriculate condition has been met with in the leaves of sorghum. This character has been designated **lg**, the normal ligulate and auriculate condition being **Lg**. **Lg**. is a simple dominant to **lg**. (*Authors' abstract.*)

The determination of sulphur for sulphur balance experiments with cattle and sheep. F. J. Warth and T. S. Krishnan. (*Ind. J. Vet. Sci. and Anim. Husb. Vol. V, Part 3*).

A new method is proposed of which the chief advantage is that a large amount of material can be used for the determination.

The accuracy thus obtained makes it possible to determine the sulphur intake and outgo of cattle with precision. (*Authors' abstract.*)

A feeding experiment with sheep : F. J. Warth and T. S. Krishnan. (*Ind. J. Vet. Sci. and Anim. Husb. Vol. V, Part 3*).

A long period feeding test has been carried out with sheep, the food consumption, live-weight and wool production being studied. Digestion trials were also carried out.

It was found that the live-weights fluctuated somewhat roughly in accordance with food consumption and that the individual animals differed considerably in their efficiency for utilisation of food.

Digestion experiments indicated that the food varied somewhat in quality and that consumption increased when the quality improved. The extent of such increased consumption was considerable.

With regard to wool yields the important observation was made that the yields fluctuated according to the nutritional state of the animals. (*Authors' abstract.*)

A statistical study of the body weight figures of special and ordinary fed calves at Pusa. P. V. Krishna Ayyar, (*Ind. J. Vet. Sci. and Anim. Husb. Vol. V, Part 3*).

This paper is a supplement to Mr. Sayer's articles on "Tables of pail-fed calf weights during ordinary and special feeding" and deals statistically with the body weight figures of calves under two systems of treatment. It has been shown that (*i*) special feeding has enabled calves to put on more weight than ordinary feeding and (*ii*) calves under special treatment grow at a slightly more rapid rate than those under ordinary treatment. (*Author's abstract.*)

Aerial roots in sorghum. G. N. RANGASWAMI AYYANGAR and V. PANDURANGA RAO. (*Current Science*, Vol. III, No. 10, April 1935, pp. 485-486).

Aerial roots functioning as stilt roots usually develop in the four bottom nodes of sorghum. The effect of the leaf-sheath on their stimulation was studied. De-sheathing stimulated them. When the sheaths were intact there was a poorer root development.

When side shoots are formed and develop an earhead the bottom nodes form aerial roots which turn flat and clasp the stem so securing the attachment. (*Authors' abstract.*)

Chromosome numbers in *Sesbania grandiflora* Pers. The *agathi* plant. N. KRISHNASWAMI and G. N. RANGASWAMI AYYANGAR. (*Current Science*, Vol. III, No. 10, April 1935, p. 488).

The chromosome number in *Sesbania grandiflora* Pers. the *agathi* plant, was determined to be seven haploid. The complement was made up of 2 long, 2 medium and 3 short chromosomes. Of the two long chromosome one was slightly longer than the other, the two medium length chromosomes were also unequal. A median attachment constriction was found in the longer and a sub-median in the shorter of these chromosomes. All the shorts had median attachment constrictions. (*Authors' abstract.*)

NOTES

SUGAR PRODUCTION IN JAVA

The June issue of the *International Sugar Journal* contains the 1934 issue of Prinsen Geerling's well-known annual report on the Java Sugar crop. The following figures are of interest as showing what standard a really efficient sugar-producing country has reached. :—

Total harvested cane area	93,613 acres.
Total cane production	5,152,122 tons.
Average yield of cane	55 tons per acre.
Average cane yield of best group	67·19 tons per acre.
Average cane yield of lowest group	47·09 tons per acre.
Average extraction	12·35 per cent on cane.
Average highest group	13·49 Do.
Average lowest group	10·53 Do.
General average sugar	15,211 lbs. per acre.
Highest group sugar	17,342 Do.
Lowest group sugar	13,733 Do.
Best factory	18,058 Do.

The following tables show the general history of the industry during the past ten years :—

I. Cane crop

Year	No. of Factories	Land under cane (acres)	Cane harvested	
			Tons	Tons per acre
1934 . . .	47	93,613	5,152,122	55·01
1933 . . .	99	208,947	11,088,662	52·21
1932 . . .	166	423,924	22,587,839	53·25
1931 . . .	178	493,721	26,100,114	52·70
1930 . . .	179	489,984	25,292,273	51·54
1929 . . .	179	486,799	24,140,899	49·59
1928 . . .	178	481,863	25,295,079	52·53
1927 . . .	178	455,806	21,113,044	46·04
1926 . . .	178	444,038	18,683,145	42·08
1925 . . .	179	439,695	19,023,897	43·19

II. SUGAR EXTRACTED

Year	Average for crop (lbs.)		Yearly maximum output of any single factory (lbs. per acre)
	Per acre	On 100 cane	
1934	15,211	12·35	18,058
1933	14,770	12·64	18,164
1932	13,310	11·16	18,247
1931	12,347	10·46	17,033
1930	13,110	11·36	18,762
1929	13,205	11·82	19,120
1928	13,433	11·45	19,635
1927	11,413	11·09	18,247
1926	9,782	10·38	16,578
1925	11,491	11·88	17,308

III. SUGAR PRODUCTION IN TONS

Year	First sugars	After products	Total product
1934	621,835	14,232	636,067
1933	1,313,093	66,162	1,313,663
1932	2,530,878	40,417	2,519,864
1931	2,670,461	123,561	2,728,776
1930	2,816,005	108,040	2,869,943
1929	2,745,971	149,441	2,858,054
1928	2,776,430	166,339	2,901,751
1927	2,279,001	83,111	2,341,538
1926	1,890,544	68,142	1,941,649
1925	2,205,201	77,876	2,263,479

V. Exportation of Java sugar

(In metric tons).

Destinations	1933
Netherlands	17,148
Belgium	1,016
United Kingdom	45,157
France	2,667
Germany	2,484
Italy	914
Sweden	..
Balkan States	..
Other European States	1,050
United States	406
Port Said, etc., f. o.	59,087
East Coast Africa	5,141
Arabia Aden	8,082
British India	351,735
Penang	20,683
Singapore	46,598
Siam	34,501
Indo-China	1,654
British Malaya	3,762
Hongkong	193,011
China	99,191
Japan and Formosa	184,876
Vladivostock	5,072
Philippine Islands	..
Australia	155
New Zealand	63,601
Polynesia	1,333
Other countries	1,063
	1,150,387

VI. Exportation of molasses

(In metric tons)

	1933
Liquid	
Great Britain	125,445
United States (Pac. C.)	..
United States (Atl. C.)	..
Aden f. o.	..
British India	2,286
Straits Settlements	..
Siam	..
Hongkong	8,188
China	..
Union of South Africa	59,895
Balkan States	..
Japan	5,000
Other countries	657
	201,471
Solidified	
British India	2,874
Siam	6,261
Straits Settlements	..
Indo-China	..
Hongkong	..
China	..
Australia	.
Total	9,135
General Total	210,606

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IMPORTATION OF 'MEXICAN JUMPING BEANS'.

The following Notification of the Government of India in the Department of Education, Health and Lands, No. F. 145/35, dated the 23rd April 1935, is published for general information :—

In exercise of the powers conferred by sub-section (1) of section 3 of the Destructive Insects and Pests Act, 1914 (II of 1914), the Governor-General in Council is pleased to direct that the following further amendment shall be made in the Order published with the Notification of the Government of India in the late Department of Revenue and Agriculture, No. 580-240, dated the 22nd June 1922, namely :—

Paragraph 8 of the said Order shall be renumbered "8 (*a*)" and after the paragraph as so renumbered the following sub-paragraph shall be inserted, namely :—

"(*b*) The importation of 'Mexican Jumping Beans' (*Sebastiania palmeri* of the family Euphorbiaceae) is prohibited absolutely."

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COTTON CONTROL IN U. S. A.

The following Proclamation issued by the President of the United States of America is published for general information :—

Whereas section 1 of the Cotton Control Act, approved April 21, 1934 (48 Stat: 598), provides :

"That in order to relieve the present acute economic emergency in that part of the agricultural industry devoted to cotton production and marketing by diminishing the disparity between prices paid to cotton producers and persons engaged in cotton marketing and prices of other commodities and by restoring purchasing power to such producers and persons so that the restoration of the normal exchange in inter-state and foreign commerce of all commodities may be fostered, and to raise revenue to enable the payment of additional benefits to cotton producers under the Agricultural Adjustment Act—

It is hereby declared to be the policy of Congress to promote the orderly marketing of cotton in inter-state and foreign commerce; to enable producers of such commodity to stabilize their markets against undue and excessive fluctuations, and to preserve advantageous markets for such commodity, and to prevent unfair competition and practices in putting cotton into the channels of inter-state and foreign commerce and to more effectively balance production and consumption of cotton."

Whereas section 2 of the aforesaid Act provides :

"The provisions of this Act shall be effective only with respect to the crop years 1934-1935, but if the President finds that the economic emergency in cotton production and marketing will continue or is likely to continue to exist so that the application of this act with respect to the crop year 1935-36 is imperative in order to carry out the policy declared in section 1, he shall so proclaim, and this Act shall be effective with respect to the crop year 1935-36. If at any time prior to the end of the crop year 1935-36, the President finds that the economic emergency in cotton production and marketing has ceased to exist, he shall so proclaim, and no tax under this Act shall be levied with respect to cotton harvested after the effective date of such proclamation."

And whereas I have considered the basic economic data pertinent to the economic situation relative to cotton production and marketing in the United States set forth in a memorandum dated January 7, 1935, furnished by the Secretary of Agriculture, which is on file in the Department of Agriculture, and other pertinent data :

Now, therefore, I, Franklin D. Roosevelt, President of the United States of America, under and by virtue of the authority vested in me by section 2 of the aforesaid Cotton Control Act, do hereby find and proclaim that

the economic emergency in cotton production and marketing is likely to continue to exist so that the application of said Act with respect to the crop year 1935-36 is imperative in order to carry out the policy declared in section 1 of the aforesaid Act ; from which finding and proclamation it follows that said Act under its terms shall be effective with respect to the crop year 1935-36 (June 1, 1935 to May 31, 1936).

In witness whereof, I have hereunto set my hand and caused the seal of the United States to be affixed.

Done at the City of Washington this 28th day of February, in the year of our Lord nineteen hundred and thirty-five, and of the Independence of the United States of America the one-hundred-and-fifty-ninth.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

The names of the following recipients of King Emperor's Birthday Honours will be of interest to the Agricultural and Veterinary Departments in India.

Knighthood : The Hon'ble KUNWAR JAGDISH PRASAD, C.S.I., C.I.E., O.B.E., Member of the Governor-General's Executive Council.

K. B. E.: GIRJA SHANKAR BAJPAI, Esq., C.I.E., C.B.E., Indian Civil Service, Secretary to the Government of India in the Department of Education, Health and Lands.

M. B. E.: Khan Bahadur Maulvi FATEH-UD-DIN, Indian Agricultural Service, Deputy Director of Agriculture, Jullundur, Punjab.

Khan Bahadur : Khan Sahib Munshi AMIR HASAN KHAN, Divisional Superintendent of Agriculture, Sarda Circle, Hardoi, United Provinces.

Rao Bahadur : MR. SHIVLINGAYA SHIVPUJAYA SALIMATH, Deputy Director of Agriculture, Southern Division, Dharwar, Bombay Presidency.

Rao Bahadur : MR. M. VAIDYANATHAN, M.A., L.T., Statistician, Imperial Council of Agricultural Research Department, Government of India.

Khan Sahib : Munshi MUHAMMAD ISHAQ KHAN, formerly Officiating Deputy Superintendent, Civil Veterinary Department, Basti, United Provinces.

Rao Sahib : DR. TARAKAD VAIDYANATHA AYYAR RAMAKRISHNA AYYAR, Government Entomologist, Agricultural Research Institute, Coimbatore, Madras Presidency.

Imperial Council of Agricultural Research

Under Rules I (46) and 22(17) of the Rules and Regulations of the Imperial Council of Agricultural Research, His Excellency the Governor-General in Council has been pleased to re-appoint the Hon'ble Sir FRANK NOYCE, K.C.S.I., C.B.E., I.C.S., Member of the Council of the Governor-General of India, in charge of the Industries and Labour Department, to be a member of the Imperial Council of Agricultural Research and also a member of its Governing Body, with effect from the 13th June 1935 on which date he relinquished his existing membership of the Imperial Council of Agricultural Research under the provision of Rule 5(3) of the said Rules and Regulations.

Under rule 1(29) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Government of Madras have re-nominated Mr. P. T. SAUNDERS, O.B.E., M.R.C.V.S., I.V.S., Director of Veterinary Services, Madras, as the representative of the Madras Veterinary Department on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, on which date he relinquished his existing membership of the Council, under the provisions of rule 5(3) of the said Rules and Regulations.

Under rule 1(30) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Government of Bombay have re-appointed Mr. E. S. FARBROTHER, M.R.C.V.S , I.V.S., Director of Veterinary Services, Bombay, as the representative of the Bombay Veterinary Department on the Imperial Council of Agricultural Research, with effect from the 30th May 1935, on which date he relinquished his existing membership of the Council, under the provisions of rule 5(3) of the said Rules and Regulations.

Under rule 1(31) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Government of Bengal have re-nominated Mr. P. J. KERR, M.R.C.V.S., I.V.S., Director, Civil Veterinary Department, and Veterinary Adviser to the Government of Bengal, as the representative of the Bengal Veterinary Department on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, on which date he relinquished his existing membership of the Council, under the provisions of rule 5(3) of the said Rules and Regulations.

MR. S. M. A. SHAH, B.Sc., M.R.C.V.S., Superintendent, Civil Veterinary Department, North-West Frontier Province, has been nominated by the Government of the North-West Frontier Province as the representative of their Veterinary Department on the Imperial Council of Agricultural Research under rule 1(37-A) of the Rules and Regulations of the Council, *vice* Mr. S. J. A., Shah, M.R. C.V.S., resigned.

Under rule 1(35) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Government of Bihar and Orissa have re-nominated Major P. B. RILEY, M.R.C.V.S., I.V.S., Director of Veterinary Services, Bihar and Orissa, as the representative of the Bihar and Orissa Veterinary Department, on the Imperial Council of Agricultural Research with effect from the 23rd May 1935, on which date he relinquished his existing membership of the Council, under provisions of rule 5(3) of the said Rules and Regulations.

Under rule 1(36) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Government of the Central Provinces have re-nominated Major R. F. STIRLING, F.R.C.V.S., F.R.G.S., D.V.S.M., F.Z.S., I.V.S., Director, Veterinary Services, Central Provinces, as the representative of the Central Provinces Veterinary Department, on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, on which date he relinquished his existing membership of the Council, under the provisions of rule 5(3) of the said Rules and Regulations.

His Excellency the Governor-General in Council has been pleased under the provisions contained in rules 1 and 43 of the Rules and Regulations of the Imperial Council of Agricultural Research to appoint the following as members of the Imperial Council of Agricultural Research and also as members of its Advisory Board :—

(*i*) Director of Agriculture, Bhopal.

(*ii*) Revenue Secretary, Bhopal.

Under rule 1 (43) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Indian Tea Association and the United Planters' Association of Southern India have re elected Mr. P. H. CARPENTER as the joint representative on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, on which date he relinquished his existing membership of the Council under the provisions of rule 5(3) of the said Rules and Regulations.

Under rule 1(44) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Indian Central Cotton Committee have re-elected Sardar Rao Bahadur BHIMBHAI RANCHODJI NAIK, M.L.C., Sagrampura, Surat, as its representative on the Imperial Council of Agricultural Research, with effect from the 4th May 1935, on which date he relinquished his existing member ship of the Council under the provisions of rule 5 (3) of the said Rules and Regulations.

Rai Sahib TEJ BHAN BAHL, B.A., a Superintendent in the Imperial Council of Agricultural Research Department, has been granted a further extension of extraordinary leave for six months with effect from the 17th May 1935.

Indian Central Cotton Committee

In pursuance of Clause (xi) of Section 4 of the Indian Cotton Cess Act, 1923 (XIV of 1923), the Governor-General in Council has been pleased to re-appoint Mr. S. V. KANUNGO, Indore State, to be a member of the Indian Central Cotton Committee, Bombay.

In consequence of vacancies caused by the retirement of nominated members, with effect from the 1st April 1935, the following have been nominated to be members of the Indian Central Cotton Committee.

By the Government of Madras

Rao Bahadur B. P. SESH REDDY, M.L.C., to represent the cotton-growing industry in the Madras Presidency.

By the Government of Bombay

Rao Bahadur C. S. SHIRAHATTI to represent the cotton-growing industry in the Bombay Presidency.

By the Government of Bengal

MR. AKHIL BANDHU GUHA.

By the Government of the United Provinces

Rai Bahadur Lala ANAND SARUP and Khan Bahadur SHAH NAZAR HUSAIN to represent the cotton-growing industry in the United Provinces.

By the Government of the Punjab

The Director of Agriculture, Punjab, to represent the Agricultural Department, Punjab.

Mian NURULLAH, M.L.C., to represent the cotton growing industry in the Punjab.

Madras

Rao Bahadur D. ANANDA RAO, B.Sc. (Edin.), I.A.S., Principal, Agricultural College, Coimbatore, has been appointed to act as Director of Agriculture from the date of taking charge, *vice* Mr. S. V. RAMAMURTI, I.C.S., posted as Collector and District Magistrate of Salem District.

Mr. R. C. Broadfoot, N.D.A., C.D.A. (Hons.) (Glas.), I.A.S., Headquarters Deputy Director of Agriculture, Madras, has been appointed to officiate as Principal, Agricultural College, Coimbatore, *vice* Rao Bahadur D. Ananda Rao on other duty as Director of Agriculture.

Mr. C. Narayana Ayyar, Dip. Agri., Deputy Director of Agriculture, IV Circle, has been appointed to officiate as Headquarters Deputy Director of Agriculture, Madras, *vice* Mr. R. C. Broadfoot.

Mr. V. T. Subbayya Mudaliyar, Assistant Lecturer in Agriculture, Agricultural College, Coimbatore, has been appointed to category 6 of Class I of the Madras Agricultural Service and to officiate as Assistant Director of Agriculture, Salem, with effect from the date of taking charge, *vice* Mr. T. R. Venkaswami Rao retired from service.

Mr. P. T. Saunders, O.B.E., M.R.C.V.S., I.V.S., Director of Veterinary Services, has been granted leave on average pay for three months and one day and on half average pay for twenty days in continuation thereof from or after the 6th July 1935.

Mr. T. J. Hurley, M.R.C.V.S., D.V.S.M., I.V.S., Principal, Madras Veterinary College, has been appointed to act as Director of Veterinary Services, *vice* Mr. P. T. Saunders, granted leave.

Mr. C. Suryanarayanamurti Pantulu, G.M.V.C., District Veterinary Officer, Vizagapatam, has been granted leave on average pay for three months with effect from the date of relief.

Mr. S. S. Thitharappa Mudaliyar, Veterinary Assistant Surgeon in the Selection Grade, has been appointed acting District Veterinary Officer, Vizagapatam, from the date of taking charge, *vice* Mr. C. Suryanarayanamurti Pantulu, granted leave.

Mr. A. Ramachandra Ayyar, G.M.V.C., District Veterinary Officer, Madanapalle, has been granted leave on average pay for three months from date of relief.

Mr. K. SESHAGIRI RAO, G.M.V.C., on return from leave, has been appointed to be District Veterinary Officer, Bellary.

Mr. M. PONNAYYA, acting District Veterinary Officer, Bellary, has been appointed, on relief, to be acting District Veterinary Officer, Madanapalle, relieving Mr. A. Ramachandra Ayyar, granted leave.

Bombay

Mr. V. N. GOKHALE has been appointed to act as Assistant Professor of Agricultural Chemistry, Agricultural College, Poona, *vice* Mr. N. Narayana, transferred.

Mr. L. L. RELWANI has been appointed as Divisional Superintendent of Agriculture in Sind, with effect from 16th April 1935.

Mr. Y. N. MARATHE has been confirmed as Deputy Director of Veterinary Services, Bombay Presidency, with effect from 17th April 1935.

Mr. D. G. HAJI, Deputy Superintendent, Bombay City and Harbour Veterinary Department, has been granted leave on average pay for four months with effect from 20th May 1935 or the subsequent date on which he may be relieved.

Mr. M. G. KULKARNI, Veterinary Inspector, Northern Range, has been appointed to act as Deputy Superintendent, Bombay City and Harbour Veterinary Department, *vice* Mr. D. G. Haji, proceeding on leave..

Mr. K. B. NAIR, G.B.V.C., Assistant Professor, Bombay Veterinary College, has been granted leave on average pay out of India for seven months and eleven days, with effect from 4th September 1935 with permission of affixing to it the college vacation from 15th April 1936 to 14th June 1936.

United Provinces

Mr. HAR NARAIN BATHAM, M.A., Agricultural Chemist to Government, United Provinces, has been granted leave on average pay for a period of 4 months, preparatory to retirement, from 16th June 1935.

Mr. GANPAT RAI SAXENA, B.A., Assistant Professor of Chemistry, Agricultural College, Cawnpore, in the United Provinces Agricultural Service, Class II, has been appointed to officiate as Agricultural Chemist to Government, United Provinces, in the United Provinces Agricultural Service, Class I, as a temporary measure, *vice* Lala Har Narain Batham, granted leave.

Mr. LAKSHMI SHANKAR NIGAM, Member, Subordinate Agricultural Service, III Grade, has been appointed to officiate as Assistant Professor of Chemistry, in the United Provinces Agricultural Service, Class II, *vice* Mr. Ganpat Rai Saxena, appointed to officiate as Agricultural Chemist to Government, United Provinces.

Syed SIRAJUL HASAN, Assistant Agricultural Engineer, Sarda Circle, has been granted leave on average pay for 4 months, with effect from 15th June, 1935, or subsequent date of relief.

Mr. PREM RAJ MITAL, Well Engineer, Cawnpore, has been appointed to officiate as Assistant Agricultural Engineer, Sarda Circle, Lucknow, *vice* Syed Sirajul Hasan, granted leave.

Punjab

On return from leave Sardar Bahadur Sardar JAGAT SINGH, B.A., M.Sc., assumed charge of his appointment as Assistant Professor of Chemistry, Punjab Agricultural College, Lyallpur, on the 2nd May, 1935, relieving Pandit Lal Chand Dharmani, who reverted to his substantive appointment in the Subordinate Agricultural Service from the same date.

Mr. CHARAN SINGH, Extra Assistant Director of Agriculture, Hansi, has been appointed Officiating Deputy Director of Agriculture, Multan, in the Punjab Agricultural Service, Class I, with effect from the 1st May 1935.

On return from leave, Mr. IJAZ AHMAD, B.Sc. Agri., resumed charge of the post of Extra Assistant Director of Agriculture, Gurdaspur, on the forenoon of the 15th May 1935.

Mr. MUKHTAR NABI, Extra Assistant Director of Agriculture, Montgomery, has been transferred to Rawalpindi with effect from the 17th April 1935.

Mr. ARJAN SINGH, L.Ag., M.Sc. Agri., Extra Assistant Director of Agriculture, Rawalpindi, has been transferred to Montgomery, with effect from the 17th April 1935, *vice* Mr. Mukhtar Nabi.

Mr. T. F. QUIRKE, M.R.C.V.S., I.V.S., Director, Veterinary Services, Punjab, has been granted leave on average pay *ex*-India for 5 months and 22 days, and in continuation leave on half average pay for 1 month and 8 days, with effect from the 9th April 1935.

Captain U. W. F. WALKER, M.R.V.C.S., M.C., I.V.S., Professor of Surgery, Punjab Veterinary College, Lahore, has been appointed Officiating Director, Veterinary Services, Punjab, Lahore, with effect from the 9th April 1935, *vice* Mr. T. F. Quirke, granted leave.

Mr. MUSHTAQ AHMAD, G.P.V.C., Hospital Surgeon, Punjab Veterinary College Lahore, has been appointed to carry on the duties of the Professer of Surgery Punjab Veterinary College, Lahore, in addition to his own duties, with effect from the 9th April, 1935.

Mr. IQBAL ALI SHAH, M.R.C.V.S., Officiating Superintendent, Civil Veterinary Department, North-West Frontier Province, Peshawar, has been deputed to attend the post-graduate refresher course at the Imperial Institute of Veterinary Research, Muktesar, with effect from 2nd April, 1935, (afternoon).

Mr. MUBARIK ALI SHAH, B.Sc. (Hons.), M.R.C.V.S., Assistant Superintendent (Stock), Government Cattle Farm, Hissar, has been posted Officiating Superintendent, Civil Veterinary Department, North-West Frontier Province, Peshawar, with effect from 2nd April, 1935 (afternoon), *vice* Saiyed Iqbal Ali Shah, M.R.C.V.S., deputed to attend the post-graduate refresher course at the Imperial Institute of Veterinary Research, Muktesar.

Mr. BAIJ NATH HANDA, B.Sc., M.R.C.V.S., Officer under training at the Government Cattle Farm, Hissar, has been posted as Assistant Superintendent (Stock), Government Cattle Farm, Hissar, with effect from 26th March, 1935, *vice* Saiyed Mubarik Ali Shah, transferred.

Burma

Mr. D. RHIND, B. Sc., I.A.S., Economic Botanist, Mandalay, has been granted leave on average pay for eight months, with effect from the 1st July 1935 or any subsequent date on which he may avail himself of it.

Mr. BA THEIN, B.Sc., B.Ag., Class II, Research Assistant in Botany, Mandalay, has been appointed to hold charge of the duties of the Economic Botanist, Mandalay, in addition to his own duties, in place of Mr. D. Rhind, I.A.S., proceeding on leave.

Capt. S. R. RIPPON, M.R.C.V.S., I.V.S., Deputy Director of Veterinary Services, has been appointed to officiate as Director of Veterinary Services, Burma, in place of Mr. D. T. MITCHELL, M.R.C.V.S., I.V.S., Director of Veterinary Services, Burma, proceeded on leave.

Mr. NYAN KYAW, G.B.V.C., Veterinary Superintendent, has been appointed temporarily to be Deputy Director of Veterinary Services, Lower Burma Charge, with headquarters at Insein, in addition to his own duties, as Veterinary Superintendent in charge of South Central Circle.

Bihar and Orissa

Mr. H. W. STEWART, Agricultural Engineer, Bihar and Orissa, has been granted leave on average pay for two months, with effect from the date on which he may avail himself of it.

Mr. SAIYID NASIRUDDIN AHMAD, Assistant Agricultural Engineer, has been appointed to officiate as Agricultural Engineer in addition to his own duties during the absence, on leave, of Mr. Stewart.

Central Provinces

Mr. P. S. NAIR, G.B.V.C., Assistant Director of Veterinary Services, has been re-posted in charge of the Veterinary Laboratory, Nagpur, on return froml eave.

Mr. M. Y. MANGRULKAR, Officiating Assistant Director of Veterinary Services, in charge of Veterinary Laboratory, Nagpur, on relief by Mr. P. S. Nair, has been deputed to take up his duties as Assistant Pathologist at the Imperial Institute of Veterinary Research, Muktesar, Kumaun, United Provinces.

REVIEW

" **Analysis of Manurial Experiments in India** " **Vols. I to III.** By M. VAIDYANATHAN, Statistician, Imperial Council of Agricultural Research (published by the Imperial Council of Agricultural Research).

This compilation and analysis of the results of the manurial experiments, carried out in India during the present century, had its origin in the recommendation of the Royal Commission on Agriculture in India that the existing material bearing on the economic use of fertilisers should be carefully studied and the results correlated. One of the first acts of the Imperial Council of Agricultural Research was to implement this recommendation by appointing a representative and authoritative Standing Fertilisers Committee which met in June 1930. The original terms of reference to the Committee were, in effect, the recommendations of the Royal Commission, and referred especially to the investigation of problems relating to the conservation and development of indigenous manurial resources.

The Committee decided that, as a first step, it would be necessary to obtain full information on the results of experiments already carried out in India. In order that this work might be done expeditiously, the Imperial Council of Agricultural Research agreed to make a grant to enable an experienced agricultural officer and a statistical assistant to be specially employed in each province for the collection of the data.

By the end of 1932 the data from all parts of India, including Burma, had been collected on the lines laid down by the Fertilisers Committee and the provincial data, together with the reports thereon by the respective officers, were submitted to the Imperial Council of Agricultural Research. The Statistician to the Council, Mr. Vaidyanathan, collated and analysed the data from the several provinces and compiled three foolscap volumes which have now been published aggregating over one thousand pages, of which over 900 are occupied by tabular statements. We now have a record of about ten thousand experiments with nearly a hundred different manures in many combinations, and carried out on 92 Agricultural Experiment Stations, in nine British Provinces and one Indian State. Mr. Vaidyanathan and his collaborators are to be congratulated on the patience and ability with which they have dealt with this mass of figures.

Nature of the data collected and their representative character

The data relate to experiments in different parts of India, and have been carried out :—

(*i*) On different types of soils and under different conditions of aspect, temperature, rainfall, irrigation and in different seasons of the year.

(*ii*) With a variety of crops—paddy, all kinds of millets, wheat, barley, tobacco, chillies, sugarcane, cotton, groundnut, coconut, potato, tea, coffee and practically every kind of food and industrial crop cultivated in India ; and with the following manures :—

(*iii*) (*a*) organic manures—farmyard manure, different green manures, composts from a variety of waste organic materials and refuse, fish guano, bone meal, horn meal, hoof meal, bone sinews, dried blood, poudrette, ashes, and all kinds of human and animal excreta.

(*b*) inorganic fertilisers—ammonium sulphate, sodium nitrate, calcium cyanamide, ammonium phosphates of different grades, rock phosphates, potassium sulphate, potassium nitrate, potassium chloride, Kainit, lime, magnesium sulphate and every other kind of fertiliser as and when it made its appearance.

(*iv*) Combinations of organic manures and artificial fertilisers.

(*v*) Time and manner of fertiliser application.

All the experimental data have been statistically examined using whatever methods were applicable. Few of the field experiments were laid out on modern lines and most were either unreplicated or quite inadequately replicated, but as they had been conducted over a series of years, it has been possible to extract a good deal of statistically significant information.

The general results in their broad aspect

A study of the data brings out most prominently: (1) that the evidence establishes the importance and suitability of indigenous organic manures like cattle manure, green manures, bone meal, fish manure and oil-cakes, to the great majority of Indian soils, and (2) that artificial fertilisers are second in importance and that they show themselves at their best in conjunction with organic manures or in the presence of adequate supplies of organic matter in the soil.

In areas of precarious rainfall or inadequate irrigation facilities, artificial fertilisers almost invariably failed to be profitable, while the effect of organic manures was erratic and uncertain.

With adequate rainfall or an assured moisture supply in the soil, the performance of artificial fertilisers was distinctly better and in many instances as good as, and some times even better than, organic manures, depending largely on the nature of the crop. Speaking generally, the returns were greatest with nitrogenous fertilisers in all parts of India ; the action of phosphates was generally evident but was marked in the 'crystalline' soil tract of Peninsular India ; the response to potassic fertilisers was rarely appreciable.

Of the nitrogenous fertilisers, ammonium sulphate was the most satisfactory, but not to such an extent as to rule out concentrated organic nitrogenous manures like oil-cakes, fish, horn and hoof meals.

Superphosphates and ammonium phosphates showed themselves to be useful phosphatic fertilisers. In combination with nitrogenous fertilisers—whether organic or inorganic—superphosphate was generally efficacious and was even superior to bonemeal, but when used alone, the action of superphosphate was often erratic.

Potassium fertilisers were not the subject of experiment to the same extent as nitrogenous and phosphatic fertilisers. On the few occasions in which they were tried, the response was either feeble or absent ; this doubtless accounts for the absence of further experiments.

Incidentally it is common knowledge that in several instances the continued use of artificial fertilisers alone has been found to lead to bad residual effects on the soil but in combination with organic manures, however, the effect was almost the reverse.

The results of experiments on the time of application of fertilisers are neither extensive nor conclusive. Such evidence as there is indicates that, in general, for crops other than sugarcane fertilisers are best applied in one application at the time of planting. For sugarcane the application of the fertiliser in two instalments seems to be preferable.

Validity of the data and of the conclusions

Doubts may arise in some quarters in regard to the validity of these conclusions since they are based on data derived from experiments the majority of which were commenced at a time when modern methods of experimentation and interpretation were not widely known. Not only have special officers in the provinces and Mr. Vaidyanathan examined all experiments in the light of modern knowledge and views, but they have taken care to evaluate the older and the modern experimental data separately. In Appendix D to Volume 1, Mr. Vaidyanathan has listed some 250 of the experiments which permitted of statistical interpretation. On the whole the conclusions arrived at from the older experiments have been confirmed in essential points by the later experiments.

The results and conclusions compared with experience in other countries

The generalisation that organic manures are of primary importance in India and that they cannot be wholly replaced by concentrated fertilisers is in accordance with more recent results in other countries also.

Sir John Russell (Hitchcock lectures in America, 1928) has shown from the analysis of the results of Rothamsted experiments that artificials were superior to farmyard manure only in the earlier years, but that later on, the yields fell below

those of the farmyard manure plots. Later, he states (Soil conditions and plant growth, 1932 and *Journal of Royal Agricultural Society, England*, 1934) that no combination of artificial fertilisers is so effective as farmyard manure in steadying crop yields from year to year. In America, Lipman and Blair (*Soil Science*, 1918) record that cow manure at ten tons per acre gave larger yields than 320 lbs of nitrate of soda. Clark and Roller (*Soil Science*, 1931) conclude that the value of farmyard manure is generally recognised to be greater than the value of its contents of the chief fertilising constituents would warrant.

Douglas (*Journal Imperial College of Tropical Agriculture*, Vol. 7) discussing manurial experiments in British Guiana, Egypt, America, Japan and China, emphasises the advantages of organic manures for paddy and urges caution in the use of artificial fertilisers. Tempany (*South African Journal*, 1928) discusses thirty-five years of sugarcane manuring and comes to the conclusion that the best effects of artificial fertilisers are obtained when used along with heavy dressings of organic manures.

Value of organic manures to Indian soils

Experiences in other parts of the world thus lend support to the results and findings from Indian experiments. The average nitrogen content of Indian soils is 0·05 per cent and the organic carbon content is 0·6 per cent. Similar figures for European soils are 0·15 per cent nitrogen and 3·0 per cent organic carbon so that European soils are thrice as rich as ours in nitrogen and five times as rich in humus and still the demand is for organic matter. The needs of Indian soils are patent, and the manurial data portray the requirements correctly. Cattle, green and other organic manures are valuable to soils because they supply what is popularly known as *humus*, which is so essential to maintain soil fertility. Organic manures supply "body," "substance" or "heart" to the soil and this artificial mineral fertilisers cannot do. The need for organic matter for Indian soils is more imperative because the destruction of organic matter is more rapid under the high temperatures obtaining in India. The rate of destruction will be appreciated when it is stated that a soil receiving cattle manure at 10 tons per annum continuously for twenty years contained at the end of the period only 0·74 per cent of organic carbon as against 0·59 per cent of organic carbon in a soil that received no organic manure at all.

Though the point does not arise directly from the data for yields, mention may be made of the newer knowledge of the functions of organic manures. There is increasing evidence in India and elsewhere that organic manures influence for the better the quality of the crop. Thus seed obtained from a crop manured continuously with farmyard manure has been found to give a better crop than the seed from a plot manured continuously with mineral manures alone, or without any manure. Likewise, the crop raised with cattle manure possessed a higher nutritive value than the crop grown with artificial fertilisers alone or without

any manure. This means that artificial fertilisers, valuable as they are as supplements, cannot altogether replace organic manures. It is thus evident, that if we neglect organic manures and endeavour to depend on artificial fertilisers, we shall be doing three things:

Firstly—we shall not be able to maintain the fertility of the soil;

Secondly—we may be failing to keep up the inherent cropping power of our seed thus nullifying the good results of plant-breeding;

Thirdly—we run the risk of producing food lacking in normal nutritive value.

Fortunately, there is now a widespread recognition of the need for devising means of improving the ryots, resources in respect of original manures by better conservation of manure and by the preparation of composts.

All those interested in the science and practice of agriculture in India are under a deep debt of gratitude to the Imperial Council of Agricultural Research and to Mr. Vaidayanathan for having made available this information for all India in an orderly form. (B. V.).

NEW BOOKS

On Agriculture and Allied Subjects

Change in the Farm. By T. Hennell. Pp. x+201 and 37 illus. (Cambridge: University Press, 1934). Price 10*s*. 6*d*.

Weed Suppression by Fertilizers and Chemicals. By H. C. Long, B.Sc. (Introduction by Sir Daniel Hall.) Pp. 57 and 23 figs. (obtainable from the Author, "The Birkins", Orchard Road, Hook, Surbiton, Surrey, 1934). Price 2*s*. net.

Farm Machinery. By A. A. Stone. Pp. XII + 466 and 85 figs. (London: Chapman and Hall, Ltd., 1934). Price 18*s*. 6*d*.

International Rules of Botanical Nomenclature adopted by the International Botanical Congresses of Vienna, 1905, Brussels, 1910, and Cambridge, 1930. (Third Edition). Pp. XI +151. (Jena: Gustav Fischer, 1935).

Manual of Grasses in the United States. By A. S. Hitchcock. (Miscellaneous Publication of the U. S. Department of Agriculture, 1935: No. 200). Pp. 1040+1696 figs. Price $1·75.

The Oil Palm in Malaya. By Buting. B. George, C.D.V., and Milsum, J. N. Malayan Planting Manual No. 1. Published by the Department of Agriculture, S. S. and F. M. S. Kuala Lumpur, 1934). Pp. IX+293. Price $2.

The Soya Bean. Its History, Cultivation (in England) and Uses. By E. Bowdidge. Pp. XII+83+18 plates. (London: Oxford University Press, 1935). Price 6*s*.

Farm Buildings: New and Adapted. By E. Gunn. Pp. VIII+86+26 figs.+12 plates. (London: London Caledonian Press, Ltd., 1935). Price 5*s*.

The Bombay Grasses. By E. Blatter and C. McCann. (Scientific Monograph No. 5 of the Imperial Council of Agricultural Research). Pp. 324+189 plates. (Delhi: Manager of Publications, 1935). Price Rs. 20-12 or 32*s*. 6*d*.

Practical Animal Husbandry. By W. C. Miller, M.R.C.V.S., F.R.S.E. and E. D. S. Robertson, M.R.C.V.S. Pp. XV+316 and 122 figs. (Edinburgh: Oliver and Boyd, 1934). Price 12*s*. 6*d*.

Recent Advances in Sex and Reproductive Physiology. By J. M. Robson, M.D., B.Sc., F.R.S.E. Pp. X +249+47 figs. (London: J. and A. Churchill, 1934). Price 12*s*. 6*d*.

Diseases of Poultry: Their Prevention and Treatment. By H. P. Bayon. Pp. 216+63 figs. (London: The Feathered World, Ltd., 1934). 5*s*.

Black's Veterinary Dictionary. Edited by W. C. Miller, M.R.C.V.S., F.R.S.E. Pp. XIII +141+326 text-figs. 8 plates. (London: A. & C. Black, Ltd., 1935). 21*s*.

Special Veterinary Pathology, a Guide to the Study of. By Runnels, R.A. Pp. 218. (Iowa: Collegiate Press, Inc., Ames., 1935). Price $3.

Helminth Parasites of the Domesticated Animals in India. By G. D. Bhalerao. (Scientific Monograph No. 6 of the Imperial Council of Agricultural Research). Pp. 352+164 figs. (Delhi: Manager of Publications, 1935). Price Rs. 7-12 or 13*s*. 3*d*.

GIPD—77 IC of AR—17-9-35—1,000.

The late Major R F Stirling, F R C V.S., F.R G.S., D V S M , F Z S

ORIGINAL ARTICLES.

MAJOR R. F. STIRLING, F.R.C.V.S., F.R.G.S., D.V.S.M., F.Z.S.:

OBITUARY.

ERRATA.

Agriculture and Livestock in India, Vol. V, Part VI.

Plate XXXVI, letterpress, *for* 'Explanation of Plates XXXVI-XXXVII' *read* 'Explanation of Plates XXXVI-XXXVIII'.

Plate XLVIII, fig. 1, *for* 'Guava plantations that were affected' *read* 'A road-side affected tree'.

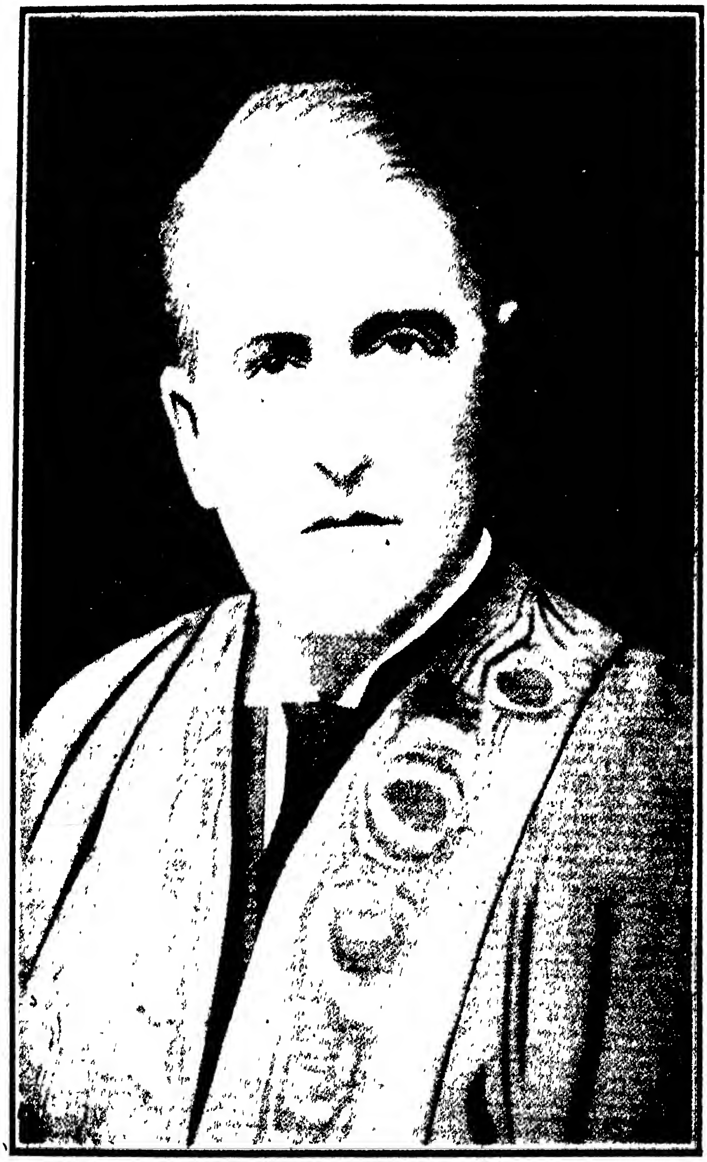
Page 695, line 6 from bottom, *for* 'mileage' *read* 'milage'.

Page 754, line 6, *for* 'protcin' *read* 'piotein'.

[illegible] Government. Further promotion was soon to be in store for him, for in 1927 his services were lent to the Government of India to officiate as Pathologist at the Imperial Institute of Veterinary Research, Muktesar. Then on the retirement of Mr. Wilson, on the 22nd February 1928, the late Major Stirling was selected by the Local Government for the permanent post, which he continued to hold up to the time of his death.

His studious habits are indicated in the learned contributions which he made to science, for one of which he was raised to the status of a Fellow of the Royal College of Veterinary Surgeons. The constant touring which he undertook in the Central Provinces and other parts of the world was recognised by the Royal Geographical Society as a reason for awarding him their Fellowship. Even during his leave periods in England, he undertook private studies and in 1925 he was awarded the Diploma in Veterinary State Medicine, after heading the list of successful candidates, a feat which is by no means common for a man of his age and with other responsibilities.

From the commencement of his service in the Central Provinces Major Stirling took the very keenest interest in controlling those deadly epizootics of cattle, which are a source of such heavy economic losses to the peasantry of this country and he will always be remembered for the part which he played in the



The late Major R. F. Stirling, F.R.C.V.S., F.R.G.S., D.V.S.M., F.Z.S.

ORIGINAL ARTICLES.

MAJOR R. F. STIRLING, F.R.C.V.S., F.R.G.S., D.V.S.M., F.Z.S.:

OBITUARY

Major R. F. Stirling, F.R.C.V.S., F.R.G.S., D.V.S.M., F.Z.S., Director of Veterinary Services, Central Provinces and Berar, was born on the 15th October 1886. He was educated at the Dublin Veterinary College and graduated as a Member of the Royal College of Veterinary Surgeons in 1907. His first appointment was to the Royal Army Veterinary Corps and for a time he worked in the Civil Veterinary Department in South Africa. During the Great War he served with the British Expeditionary Force on the Western Front, and after its termination he retired from the Army and joined the Indian Veterinary Service on the 8th April 1920, being posted to the Central Provinces as Second Superintendent under Mr. C. W. Wilson.

It was not long before he was called upon to shoulder the onerous task of controlling the Civil Veterinary Department in the Central Provinces, for on the 10th November 1923, he was appointed to officiate as Superintendent and Veterinary Adviser to Government. Further promotion was soon to be in store for him, for in 1927 his services were lent to the Government of India to officiate as Pathologist at the Imperial Institute of Veterinary Research, Muktesar. Then on the retirement of Mr. Wilson, on the 22nd February 1928, the late Major Stirling was selected by the Local Government for the permanent post, which he continued to hold up to the time of his death.

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From the commencement of his service in the Central Provinces Major Stirling took the very keenest interest in controlling those deadly epizootics of cattle, which are a source of such heavy economic losses to the peasantry of this country and he will always be remembered for the part which he played in the

introduction, in the field, of goat virus vaccination to protect cattle against rinderpest. Not only did he undertake this campaign with great zest himself but he was able also to arouse the enthusiasm of his subordinates in all matters pertaining to the advancement of veterinary science, and it was under his aegis that the Central Provinces Veterinary Association and the Central Provinces Veterinary Journal were launched.

His sudden death at Nagpur on the 16th August 1935, has created a vacancy in the Civil Veterinary Department of the Central Provinces and Berar which it will be very difficult to fill, for the seven years during which he held charge of the Department have been some of the most momentous in its history. It is a tragedy that Mrs. Stirling was in England at the time and was hoping to be able to return to India in October. We desire to convey our sincere condolences to her and to other members of the late Major Stirling's family in their great bereavement. (G. S.).

THE MOST PRACTICAL METHODS OF CONTROL OF ENTOZOAL PARASITES IN INDIA*

BY

M. ANANT NARAYAN RAO, G.M.V.C.,

Lecturer in Parasitology, Madras Veterinary College

Entozoal parasites are those that live inside the body of other animals called "hosts" and obtain food and protection from them. Entozoa themselves are animals in which special development has taken place in accordance with the mode of life which they have adopted. Entozoa may be single-celled, when they are called protozoa, or they may be made of many cells, when they are named metazoa. An animal is said to be a "definitive" or final host of a parasite when the sexual stages of the latter are found in the former, and the larval or asexual stages are found in what are called "intermediate" hosts. Parasitic infestation to healthy animals may be either direct or through an intermediate host. The pathogenic effects on the final host depend on the number of parasites, their habits, migration in the host and the degree of adaptation between the host and the parasite. It is essential to have a knowledge of the life-histories and the habits of the parasites concerned to enable one to adopt effective measures of control. In helminth parasites, the time that elapses from the egg stage to the infective larval stage is the most critical period in its life cycle and a knowledge of the stages of development during that period gives us a clue in adopting control measures.

A. *Protozoa*.—These are unicellular animals which live in the blood and tissues of animals. Among these there are three important ones which affect the domestic animals, particularly cattle.

1. Piroplasma organisms cause the so-called "Tick fever" or "Red water". These organisms are found in the red blood cells which are destroyed. The affected animals suffer from fever, jaundice, red urine, etc., and die in seven to ten days. Trypanblue is a cheap specific for this disease in cattle and the animal is to be injected with a solution of this drug. The intermediate hosts concerned are ticks. Ticks, usually the females, suck blood from animals, during which process they remain on their hosts for two to four days. When they have sucked blood to repletion, they fall off and crawl into crevices of the ground or in the buildings and lay eggs. The eggs hatch into larvae called "seed ticks." These reach the animals, suck blood and fall off. They then moult and become nymphs and repeat the process to become adults. It is during these intermittent feeds that the ticks receive and transmit infection to other cattle. Hence they have

*This is the second of a series of popular articles for practical farmers on various animal husbandry subjects of general interest.

o be dealt with when they are on the animal's body and in the crevices of the ground. To destroy ticks the bodies of the animals should be sprayed with a ½ per cent solution of sodium arsenite (sheep or cattle dip), or the flock or herd may be dipped in such solutions in special tanks built for the purpose. The floors and walls of the sheds or pens, where the animals are housed, should be scraped and burnt and the crevices filled up with mortar. If pasture lands are infested with ticks it is best to starve the ticks out by closing the pastures for a year after dressing the ground with lime or salt, or by burning the pasture. The choice depends on the nature of the land infested. Roughly about a ton of lime or half a ton of salt per acre will be required for top-dressing. It is a good policy to adopt pasture rotation, which will help in starving the ticks to death.

2. Trypanosomes are unicellular animals found in the plasma of the blood of infected animals and cause "Surra" among domestic animals in India. The animals suffering from this disease, particularly horses, get varying periods of high fever, anaemia, swelling of the dependent parts of the body and die in about four to six weeks. Some cattle die suddenly without any premonitory symptoms of the disease. The life-history of this parasite is not yet worked out, but it is believed that the large horse fly, called *Tabanus*, is the vector and mechanically transmits the organisms from the diseased to healthy animals. These flies are usually active in the early part of the day and evening. Hence movements of animals in Surra areas, particularly of horses, should be after sunset or before sunrise. The flies breed in swamps and over water, and this can be prevented by draining the swamps and removing weeds overhanging the water. In Bayer 205 or Naganol is to be found both a prophylactic and a curative for this disease, but it needs to be given intravenously by a veterinary graduate.

3. Coccidia are unicellular animals that infest the lining membrane of the intestines of animals. In infected animals considerable damage is done to the intestine particularly in young stock, and severe diarrhoea or dysentery results. Prophylaxis consists in destroying the faeces of badly infected animals, as these contain the spores of the organism. Ploughing up the infected pastures will improve matters, and also improve the pasturage. No curative treatment is known.

B. *Metazoa*.—The endoparasitic metazoa can be divided into two groups, *viz.*, the flat worms and the round worms. Among the flat worms are flukes and tape-worms.

1. *Flukes*.—These worms may live in the bile ducts of the liver, the small veins of the liver and intestine, the nasal mucous membrane or in the lumen of the intestines. They may be as large as the common liver-fluke (*F. gigantica*) and act as so many plugs to the bile ducts and throw the liver out of gear, or they may be small, like the blood fluke (*S. nasalis*) in the veins of the mucous membrane of the nose, or like *S. spindalis* in the veins of the liver. The eggs of the blood-flukes on their way out of the body cause considerable damage to the tissues through which

they pass and produce disease. The affected animals may be treated with tartar emetic, antimosan, extract of male fern, or carbon tetrachloride, etc., according to requirements. The life-histories of the flukes in general are alike in that they require some kind of fresh water snail as an intermediate host. The eggs passed in faeces or with the nasal discharge get access to fresh water, hatch out and the embryos enter the kind of snail required by them and in this intermediate host they develop into a number of larvae which are discharged into the water in about six weeks after the entry of the embryo. From one embryo some thousands of larvae develop, and the infected snail can go on discharging these larvae daily for a week or two. These larvae are good swimmers and those of the liver-flukes and intestinal flukes attach themselves to weeds in water and remain there for considerable periods till they are eaten by herbivorous animals along with the weeds ; some other kinds of larvae enter another aquatic animal like fish, crab, etc., and encyst there till they are eaten by the definitive host ; yet other larvae like those of the blood-flukes will enter directly through the skin of the definitive host when the latter comes in contact with such infested water or enter through the mucous membrane while the host is drinking it. Hence, we have to break a link in the chain of the life-history of these flukes in order to prevent animals getting infested, and the best way to do this is to destroy the snails in ponds or streams the water of which is used for drinking. The fresh water snails feed upon weeds, hence if ponds, etc., are cleared of these, the snails starve and die. Copper sulphate or blue stone is a poison to snails even in high dilutions whereas in small doses it is a tonic to animals. A handful or two of blue stone powdered and made into a solution can be poured into the water of the ponds along the edges to kill the snails. Another method is to kill the larvae and this can be done by throwing lime in the water or by storing the water for at least 48 hours by which time the larvae die, when the water can be used with impunity.

2. *Tape-worms.*—Tape-worms have a long tape or ribbon-like body. Each worm has a head or scolex provided with hooks and suckers usually and this is followed by a large number of segments, which together constitute the tape-like body. Generally, these parasites require an intermediate host to complete their life-history. These worms may be a few millimeters to several meters in length. Each segment is an individual, is hermaphrodite and when it is full of ova the segment is said to be ripe or gravid. The segments when ripe break off from the rest and are passed in the faeces. The segments that are passed out in faeces disintegrate, and if they are on grass, the contained ova contaminate the grass on a pasture or even the drinking water may get contaminated with ova. When these ova are swallowed by animals, the embryos hatch out in the stomach and intestines, burrow through the intestinal wall and enter such organs as the liver, lungs, brain, etc., and form bladder-worms which may be small or large and may press upon and destroy the tissues of the organs. Such organs may be thrown out of gear and interfere with the animals' health. Even human

beings may be subject to infestation with bladder-worms. Each bladder-worm contains in it one or more heads or scolices of the tape-worm and when meat containing such bladder-worms is eaten by the definitive host, the bladder is digested, the scolex or head is liberated, attaches itself to the intestinal wall of the definitive host and develops into an adult tape-worm. It is interesting to note that the dog is the definitive host of a large number of tape-worms and cattle unwittingly play the part of intermediate hosts of almost all of them. In being the intermediate hosts they suffer more than they would if they were subject to adult tape-worms peculiar to them as definitive hosts. To give an example, a tape-worm of the dog called *Multiceps* passes its bladder-worm stage in sheep and the bladder-worm may be found in the brain causing "Gid" or "Sturdy" and may even produce death if the infestation is heavy; whereas such tape-worms as those of the genus *Moniezia*, the adults of which are found in the intestines of sheep, may not produce much harm. Further, one can treat and rid the sheep or other animals of tape-worms in their intestines, but no treatment is of any use against the bladder-worms that have formed in the tissues or organs of animals. The easiest way out of this difficulty, therefore, lies in prevention, which is best attained by not allowing dogs on pasture lands, and thus preventing contamination of grass or water which is the source of all the trouble. Pet dogs on farms must be treated frequently to destroy the tape-worms they may harbour and their faeces burnt. The usual drugs employed in expelling adult tape-worms from the intestines of animals are extract of male fern, arecanut powder, pomegranate root, etc. Ploughing up infected pastures and preventing cattle from grazing in low-lying lands is indicated. Dogs get infested by eating the offal from slaughter-houses which may contain the bladder-worms. So these have to be killed by cooking the meat thoroughly before feeding it to dogs.

3. *Round-worms.*—There is a fairly large number of round-worms that parasitise animals. In some of them the infestation is conveyed direct to animals either by swallowing embryonated eggs or by the embryos hatching out on the ground and infecting the host through the skin or mucous membrane. Examples of these are the large round-worms (*Ascaris*), hook-worms and wire-worms (*Haemonchus*) of sheep and cattle. The ova of all the worms that inhabit the intestines are passed in the faeces. In each ovum of an ascaris worm in about ten days or longer, a larva develops, but the egg does not hatch. The ova can remain in this condition for months or for several years, unless they are exposed to heat and direct sunlight when they die. When such embryonated ova are swallowed with contaminated food or water, the eggs hatch in the intestines, the larvae burrow through the wall of the intestines and migrate through the liver and lungs before reaching the intestines a second time for development into maturity. The migration causes considerable damage to the organs through which the larvae pass. In some worms such as the wire-worms, the eggs hatch in the open and the larvae become infective in about 4 days provided there is enough

moisture in the field. These larvae crawl up the moist grass and get swallowed with it. In about a fortnight they develop into adults in the intestines, and ova may appear in the faeces of newly infected animals within three weeks after primary infestation. It would appear therefore that the larvae or the embryonated eggs require moisture to remain viable and such a condition is always present in low-lying or marshy places and along the edges of a pond. Hence, marshy places should be drained and weeds removed along the edges of ponds to prevent larvae on them infecting animals that graze there.

Some other round-worms require an intermediate host to complete their life-history. There appear to be three ways by which the intermediate host may get infected :—(*a*) The eggs may be eaten by the intermediate host, for example, a dung beetle or cockroach may eat the faeces of a dog containing ova of certain red-worms (*Spirocerca*) found in tumours in the gullet of dogs. The ova hatch and the larvae get encysted in the beetles or cockroaches till these are eaten by another dog.

(*b*) The eggs passed in faeces will hatch and the larvae enter an intermediate host. In the horse there are certain worms (*Habronema*) that parasitise the stomach. The ova of these are passed in these faeces and these are thrown on a manure heap. The ova hatch into larvae there. In manure heaps, house flies and stable flies breed. Their maggots are parasitised by the larvae of Habronema. The maggots of the flies pupate and hatch out into flies. These flies have in their bodies or in their mouth-parts the infective larvae. When these flies are accidentally swallowed by the horse they get digested and the larvae become free to parasitise the stomach or the larvae may escape from the mouth-parts of the flies on the body of the animals and be licked up.

(*c*) Some worms (*Filaria*) lay larvae instead of ova in the animal's tissues and these larvae enter the blood stream and remain circulating in it. A blood sucking intermediate host, such as a mosquito, while feeding sucks them up along with the blood. The larvae develop further in the mosquito and ultimately reach the biting parts of the mosquito in about three weeks. When the mosquito bites again, these infective larvae, which are attracted by the warmth of the new host, emerge from the biting parts, penetrate the skin of that host and wander to that organ in which they can develop into adults.

The ways and means to be adopted in combating infection with nematodes vary and they are enumerated below :—

(*i*) The adult worms should be got rid of, while within the definitive hosts, by giving suitable drugs. To this end, the kind of worm that is parasitising the host should be ascertained by examination of faeces, etc., and suitable remedies given to the animals. It is best done during the dry season for obvious reasons. The common drugs used are Ol-chenopodium, santonin, nema capsules, etc.

(*ii*) The ova or their embryos should be killed while within the final host. In such diseases as nasal or intestinal *Schistosomiasis* or in *Filariasis*, intravenous injections of tartar emetic, antimosan and the like will help in destroying them.

(*iii*) The entry into the body of the infective larvae or embryonated ova should be prevented. If round-worm (*Ascaris*) infection is suspected, plough up the land preferably with some quick lime in it to destroy th embryonated ova. When infective larvae are suspected to be present on grass, do not allow the animals to graze till the dew dries off the grass. It is a useful plan to keep animals off low-lying lands, and other wet places like the edges of pools of water, etc.

It is always beneficial to carry out rotation of pastures. If over-crowding of stock is avoided, then the infestation of ova on a pasture is reduced, the animals will have a larger area to graze and the amount of infest ation in animals will be lowered. The intermediate hosts must be either destroyed or prevented from becoming infected. The manure must be disposed of properly. In dry climates the manure can be spread out to dry and collected, or it may be closely packed so that the heat generated during fermentation destroys the ova or larvae. A layer of earth may be thrown over fresh manure every time it is added to the heap. This will prevent flies, etc., breeding there. Steps should be taken to keep down the number of such intermediate hosts as earthworms, beetles, biting flies and such other insects. The bionomics of these creatures have to be studied and suitable methods employed to keep them under control.

It has been found that well-nourished animals are usually free from infestation with parasites. To obtain such animals a supply of minerals is necessary, and whenever a pasture is deficient in these, they should be supplied to the animals. This is best done by supplying " licks " to the animals of the minerals deficient in the pastures. It is a well-known fact that young animals are more susceptible to worms than adults, hence they have to be provided with proper nourishment to keep them free from infestation. Stall-fed animals should be fed from raised troughs and care should be taken that the straw or hay and water is not contaminated with faeces on the floor.

GRAM-WILTS IN THE CENTRAL PROVINCES

BY

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Gram (*Cicer arietinum*) is grown extensively in many parts of the Central Provinces, but as a rule it is remarkably free from diseases. The most important diseases to which this crop is susceptible in this Province are those which go under the common name of wilt. There are two distinct kinds of wilts, though ordinarily no distinction is made between the two by the cultivators. One of these two wilts is considered to be due to physiological soil-conditions and the other is caused by *Rhizoctonia bataticola* (Taub.) Butl.

The physiological wilt causes much more damage than the *Rhizoctonia* wilt; the former is confined only to certain varieties and plants are susceptible to this wilt at any stage in their growth, a plant a week or two old being as susceptible as the mature plant, whereas the second type of wilt attacks many varieties of gram, but the damage done is not extensive and plants become wilted when they are mature.

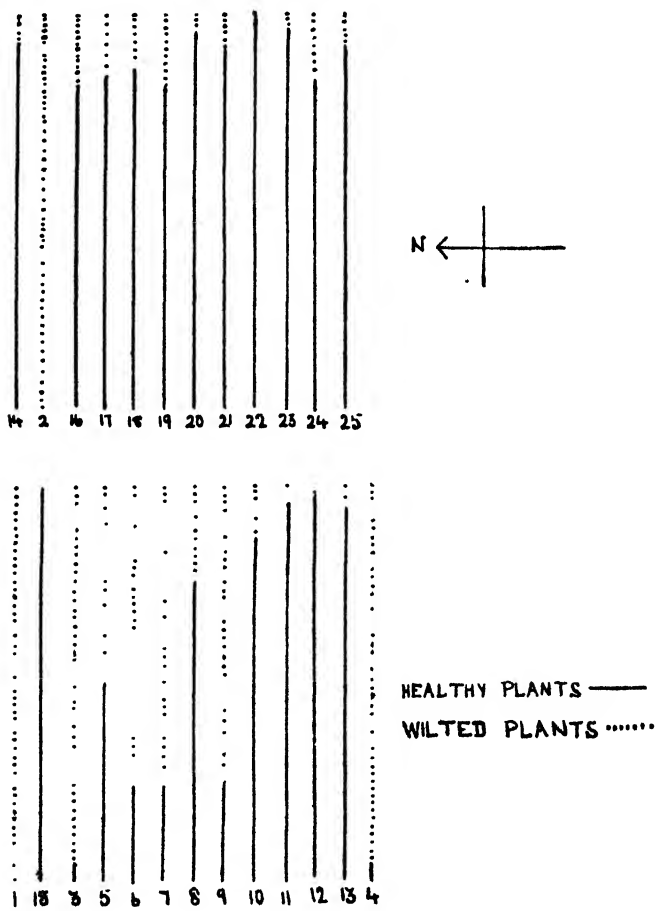
Physiological wilt.—Diseased plants are not found scattered all over a field but are always grouped together in patches. Plants show signs of wilt at any stage in the development of their growth. The first sign of disease is the drooping of the upper tender parts. The plant looks as if it is starved for water. There is a slight loss of colour of the wilting parts of the plant, which look faded and whitish green in colour. A day or two after these first signs of disease the whole plant shows typical signs of wilt. There is a general fading of the green colour, the plant looking whitish green as if it were partially bleached; the upper parts of the plant and leaves hang down limply. The wilted plant may with age gradually turn brown, when it is left standing in the field for a long time. It does not readily shed its leaves, but during spells of high winds some of the leaflets may be blown away.

The underground parts do not show any characteristic symptoms. They are quite dry and shining silvery whitish in appearance. There is no external sign of rot.

From the underground roots of a wilting plant in a large number of cases a species of *Fusarium* has been isolated. This *Fusarium* has invariably failed to produce wilt in plants inoculated with it. Inoculations of seedlings and plants of varying ages were made either through wounds at the collar, or through wounded tap-roots and lateral roots or by mixing the soil with the fungus before the seeds were sown. The soil used for these experiments was either from an affected field or from a healthy field; these soils were in some cases steam-sterilized.

As it was observed that certain varieties were more susceptible than others and that the disease was confined to certain parts of a field, different varieties were tried in a field in which the incidence of wilt had been observed in the past.

In the winter of 1927, small samples of twenty-five Pusa types of gram were kindly sent by Dr. Shaw, Imperial Economic Botanist, to test their resistance to wilt. These were tried in a part of a field known to be wilt-affected. The types were distributed over this plot without any fixed plan as shown in Sketch 1.



SKETCH 1.—A plan showing the relative positions of the Pusa Types 1 to 25 sown in single lines in 1927. The dotted lines indicate the percentage of wilted plants in each type and the continuous lines represent the percentage of healthy plants.

This plot was longitudinally divided into thirteen equal long rows. In each row two varieties were sown, one on the upper half and one on the lower half, except in the 13th row where only one variety was grown in the lower half.

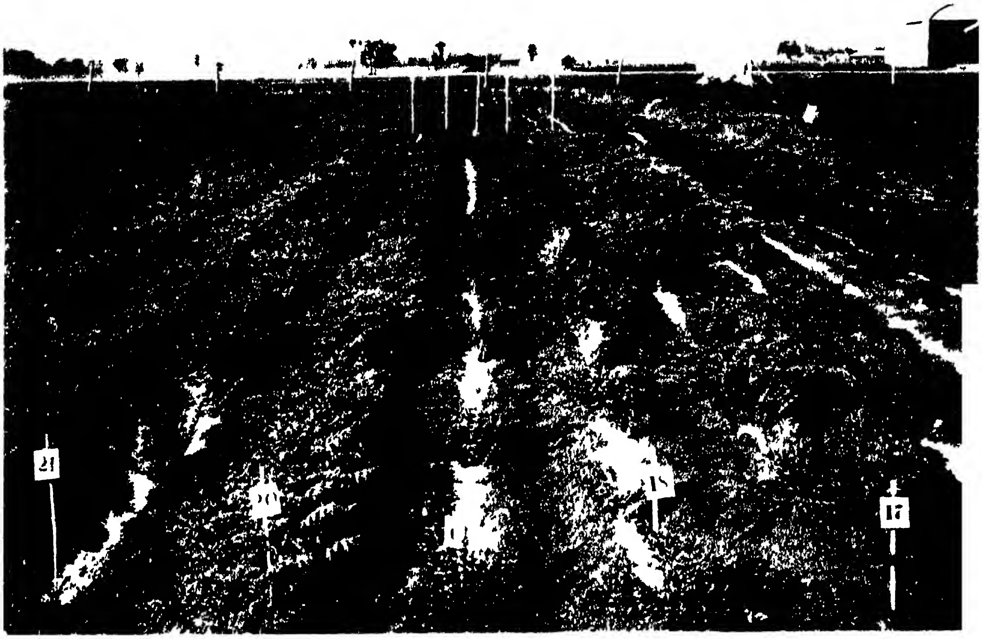


Fig.

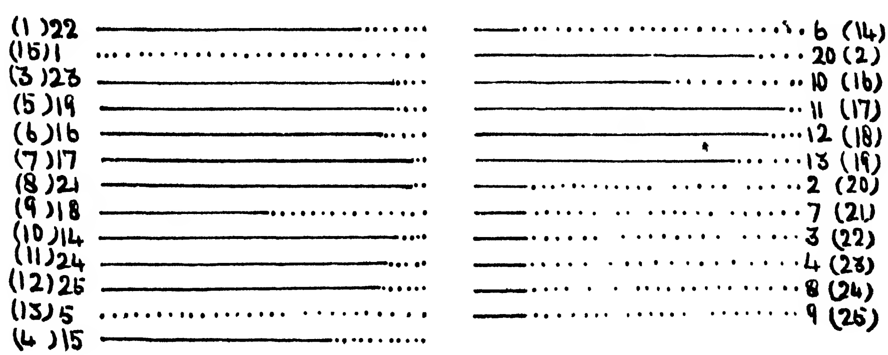
Fig. 2

The difference in susceptibility to wilt could be marked from the third week after sowing. Types 1 and 2 were the most affected, about 80 to 90 per cent of the plants were wilting. Type 4 was a little better, about 75 per cent showing signs of wilt. Types 3 and 9 showed about 50 per cent deaths ; Types 5, 6 and 7 about 25 per cent ; Types 8, 10, 12, 13, 14, 16, 17, 18 and 19 were very little affected, there being stray cases of wilt in each of these types ; Types 11, 15, and 20 to 25 were totally free from wilt. By the middle of January 1928, Types 3 and 4 were as badly wilted as Types 1 and 2 had been a month earlier ; in Types 6, 7 and 9 the percentage of wilt had increased to about 75, in Type 5 to 50, and in Type 8 to 25 ; the remaining types were more or less resistant to wilt.

In March, at the time of harvest, practically every plant of Types 1 and 2 had wilted and dried up. In Types 16, 17, 18 and 19 a few wilted plants were found.

In this particular part of the field susceptibility or resistance to wilt in a type did not seem to be influenced by the position of the row in which it was placed. For example Type 15 which was practically free from wilt was between Types 1 and 3 which were almost wholly destroyed by wilt ; and in the other half of its row was Type 2 which was completely wiped out by wilt, Type 2 being between Types 14 and 16 which were resistant to wilt (Plates XXXVI—XXXVIII and Sketch 1).

In 1928 these twenty-five Pusa types were again tried in the same part of the wilt-affected field as in the previous year. A fresh lot of seeds was kindly supplied by the Imperial Economic Botanist. The types were not sown in the same rows in which they were the previous year, but they were made to change places so that those which had shown resistance to wilt were sown where the previous year were susceptible types and *vice versa*. Thus, for example, Type 1, highly susceptible to wilt, was replaced by the resistant Type 22 and it, in turn, took the place of Type 15, another resistant type, which was sown in place of Type 4 (Sketch 2).



Healthy plants ————

Wilted plants ....

SKETCH 2.—Plan showing the relative positions of the Pusa Types 1 to 25 sown in the same plot in 1927 and 1928. The figures in brackets refer to the type numbers sown in 1927; the other figures refer to the type numbers sown in 1928.

When the plants were a few weeks old, Types 7, 8 and 9 showed the highest mortality due to wilt; Types 11, 12, 13, 16, 17 and 21 showed more or less complete resistance, the remaining types showed varying degrees of susceptibility between these two extremes. About the second week of January, Types 1 to 6 were found to be practically completely wiped out by wilt along with Types 7, 8 and 9. At the end of the season the death rates in the different types were as follows :—

Type Nos.	Percentage of deaths
1 and 5	100
2, 3, 4, 6, 7, 8 and 9	90
18	50
10	40
15	30
13 and 22	20
16, 20 and 25	15
24	12
12, 14, 19 and 23	10
11, 17 and 21	5

Thus, at the end of the season, of the six types which at first seemed to be resistant, only three maintained their resistance, *viz.*, Types 11, 17 and 21, and Types 12, 13 and 16 showed more susceptibility to wilt towards the latter part of the season.

Since after repeated trials most of the Pusa types were found unsuitable, either because they were very susceptible to wilt or they were late flowering varieties, only Types 17 and 25 were further used for trials

During the years 1926 to 1929 other varieties, like Nagpur 28[1], Local Poona[2] and Cawnpore[3], were also tried on a large scale in the same field as the Pusa types. These varieties were not sown in the same plot each year, but their positions were changed so that where one year Nagpur 28 was sown the following year Cawnpore or Local Poona was sown, and Nagpur 28 was sown where the previous year Local Poona or Cawnpore was; thus, in the course of four years, each of these varieties was tried on every part of the field except where the Pusa types were being grown. Cawnpore and Local Poona in all these trials were found to be consistently more or less wilt-resistant though not wholly immune; but Nagpur 28 was not always equally badly susceptible. Twice the whole plot was completely wilted, once the loss from wilt was negligible and another year it was partial.

[1] Nagpur 28, a local selection made by the Economic Botanist, Nagpur.

[2] Local Poona was kindly supplied by the Economic Botanist at Poona.

[3] Cawnpore was kindly supplied by the Economic Botanist at Cawnpore, U. P.

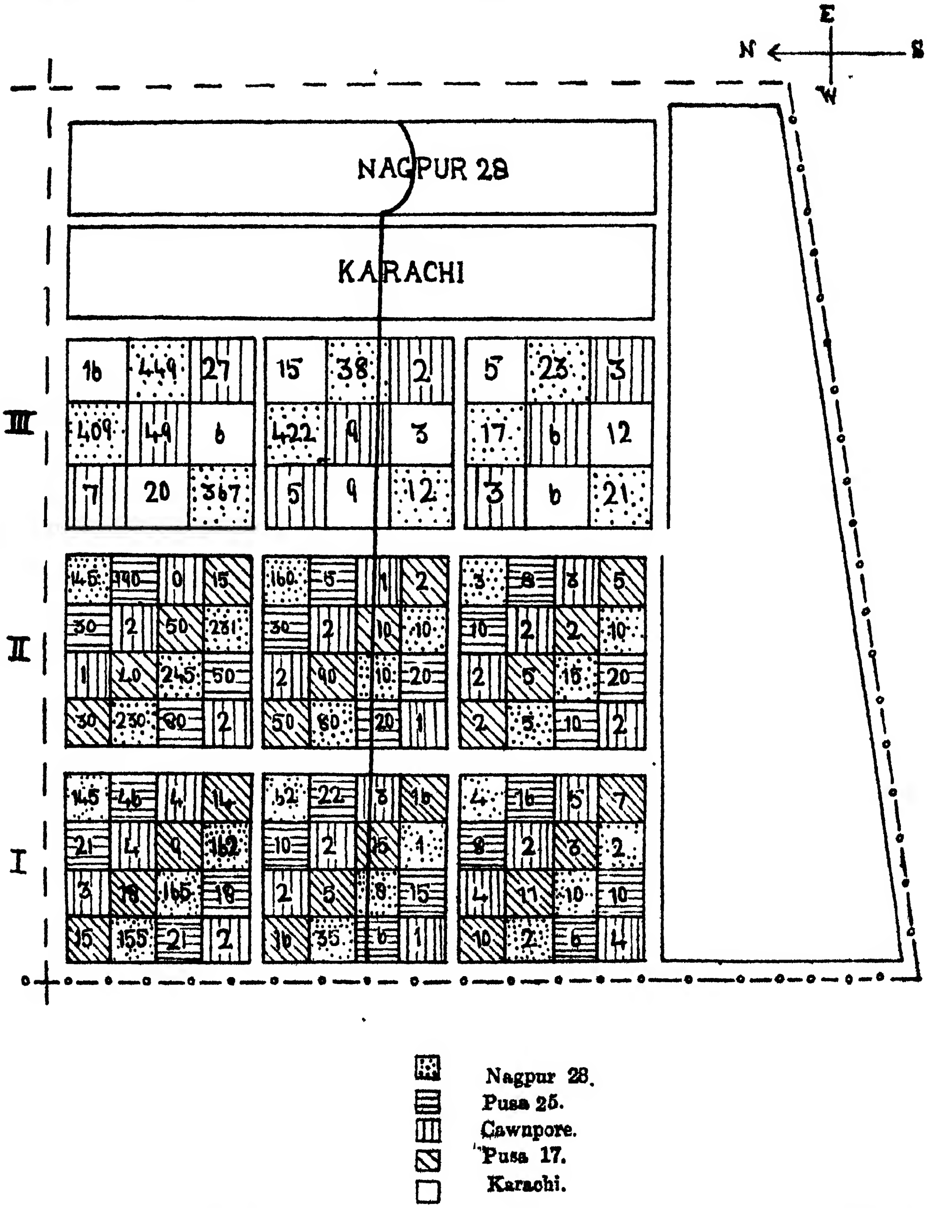
The susceptibility of Nagpur 28 to wilt may have been either influenced by climatic or soil conditions. It did not seem probable that climatic conditions played an important part in the incidence of the disease, first because the susceptible Pusa types did not show any marked variation in susceptibility to wilt during these four years of trial, and secondly because in the wilt-affected parts of the non-experimental fields on the Agricultural College Farm at Nagpur, where Nagpur 28 was extensively grown, the incidence of wilt was not observed to be variable. These wilt-affected areas in non-experimental fields had been plotted out in 1927 and had been kept under observation for three years.

It seemed probable that the susceptibility of Nagpur 28 to wilt was influenced by soil conditions. Therefore, in 1929 the whole of the field, where wilt experiments were conducted, including the portion where the Pusa types had been tried the previous three years, was divided into a number of small squares, each square being 11 feet by 11 feet. The varieties were so grown that each of them was repeated in eight squares scattered all over the field. The varieties tried were Pusa Types 17 and 25, Cawnpore and Nagpur 28. Local Poona, though considerably resistant to wilt, was not included in these trials as it was a late-maturing variety and therefore not suitable for this Province.

As the Pusa types were received very late, the grams for these trials could not be sown before the end of November and since there was a failure of late rains in 1929, the germination was very poor and therefore no definite conclusions could be arrived at from these experiments.

In 1930 these different varieties with the addition of the Karachi variety were again tried in chess-board pattern plots. Karachi variety was kindly supplied by the Economic Botanist, Burma, from Burma where it has been found to be wilt-resistant [McKerral, 1923]. On account of the shape of the field, the chess-board pattern trials were made in three blocks (Sketch 3). Blocks I and II were of equal size, each being 0·1395 acre in area, and Block III was 0·281 acre in area. Blocks I and II were each divided into three equal square plots, each plot being further divided into 16 small squares, 11 ft. × 11 ft. each, and Block III was divided into three equal square plots, each of which was further divided into nine squares, 15 ft. × 15 ft. each. In Blocks I and II gram varieties Nagpur 28, Pusa 25, Pusa 27 and Cawnpore were tried, each variety being repeated 24 times. In Block III Nagpur 28, Karachi and Cawnpore were tried, each variety being repeated nine times. In the three blocks the seeds were sown with hand on the 6th of October and a month later the seedlings were thinned out, so that in Blocks I and II each square had 250 plants and in Block III each square had 480 plants. By the end of January 1931, it was evident that wilting had not taken place uniformly all over the field. The northern part was found to be most wilt-affected, wilted plants towards the southern end being few and far between. This was most conspicuous in the case of Nagpur 28 ; in the wilt-affected northern

end of the field there were as many healthy plants of this variety as there were wilted plants towards the southern end (Sketch 3).



SKETCH 3.—Plan of the field where gram varieties were sown in 1930 in randomised squares and in two rectangular plots. At the beginning of the experiment the number of plants in each square in Blocks I and II was 250 and in Block III was 400. The figure in each square indicates the number of wilted plants in it at the end of the experiment. The heavily wilted area lies to the right of the black line running from east to west.

Fig 1

Explanation of Plate XXXIX.

Gram-wilt experiments.

Fig. 1. In the foreground is Nagpur 28; the square being practically bare of plants. The square on the right is of Karachi and on the left is of Cawnpore; in both these squares there are hardly any gaps due to death of plants.

Fig. 2. Nagpur 28 and Karachi sown in long strips to the east of the randomised squares. In the foreground is Nagpur 28. Note the bare patch to the left of the label caused by the wilting of plants. On the right there are hardly any gaps. The whole strip of Karachi at the back is full of healthy plants.

Towards the eastern end of the same field Karachi and Nagpur 28 were also sown in two rectangular plots, each being 0·065 acre in area. At the end of the season the northern part of the Nagpur 28 plot was practically bare, healthy plants being few and far between, whereas in the remaining part of the plot there were only a few scattered plants dying of wilt (Plate XXXIX, fig. 2). The few plants of Karachi which were wilt-affected were also located in the northern part of the plot.

From the presence of dead and dying plants the whole field could be easily divided into two parts by a line running east to west (Sketch 3), the part of the field situated to the north of the dividing line was badly wilt-affected ; plants of susceptible varieties, like Nagpur 28, dying in large numbers. None of the varieties tried has been found to be wholly immune in this part of the field ; resistant varieties, like Karachi and Cawnpore, also are susceptible to wilt, but to a very small degree. Whilst in the other part to the south of the dividing line there are very few cases of wilt both in the susceptible and resistant varieties.

In 1931 these experiments were again repeated on the same field. The different varieties were planted in randomised plots, but special care was taken that none of the varieties was sown in the same squares as in the previous year. The results have been practically the same as in the previous year ; wherever Nagpur 28 was planted in the wilt-affected area of the field it was badly wilted but it remained practically healthy in the other parts of the field. The two long strips, each 0·065 acre in area, to the east of the chequered plots and running from north to south were again sown with Karachi and Nagpur 28, but these two varieties had interchanged places this year. The result was the same as in the previous year. Karachi remained more or less free from wilt, though on the northern side of the same plot Nagpur 28 was badly wilted the previous year ; in the plot where Nagpur 28 was grown there was considerable wilt though in the previous year in this very plot Karachi had been grown and had remained more or less healthy (Plate XXXIX, fig. 2) ; wilted plants were not scattered but confined to the northern part of this plot ; the wilted area being in continuation of the part of the other strip in which Nagpur 28 was badly wilted the previous year.

In 1932 these experiments were again repeated exactly on the same lines as in 1930 and 1931 ; the different varieties had once again interchanged places. It was again seen that the wilted patches were not scattered all over the field, though the squares in which the susceptible variety was grown were distributed all over the field ; the largest number of wilted plants was found in the northern part of the field as in the previous years. Wilt in the remaining part of the field was negligible.

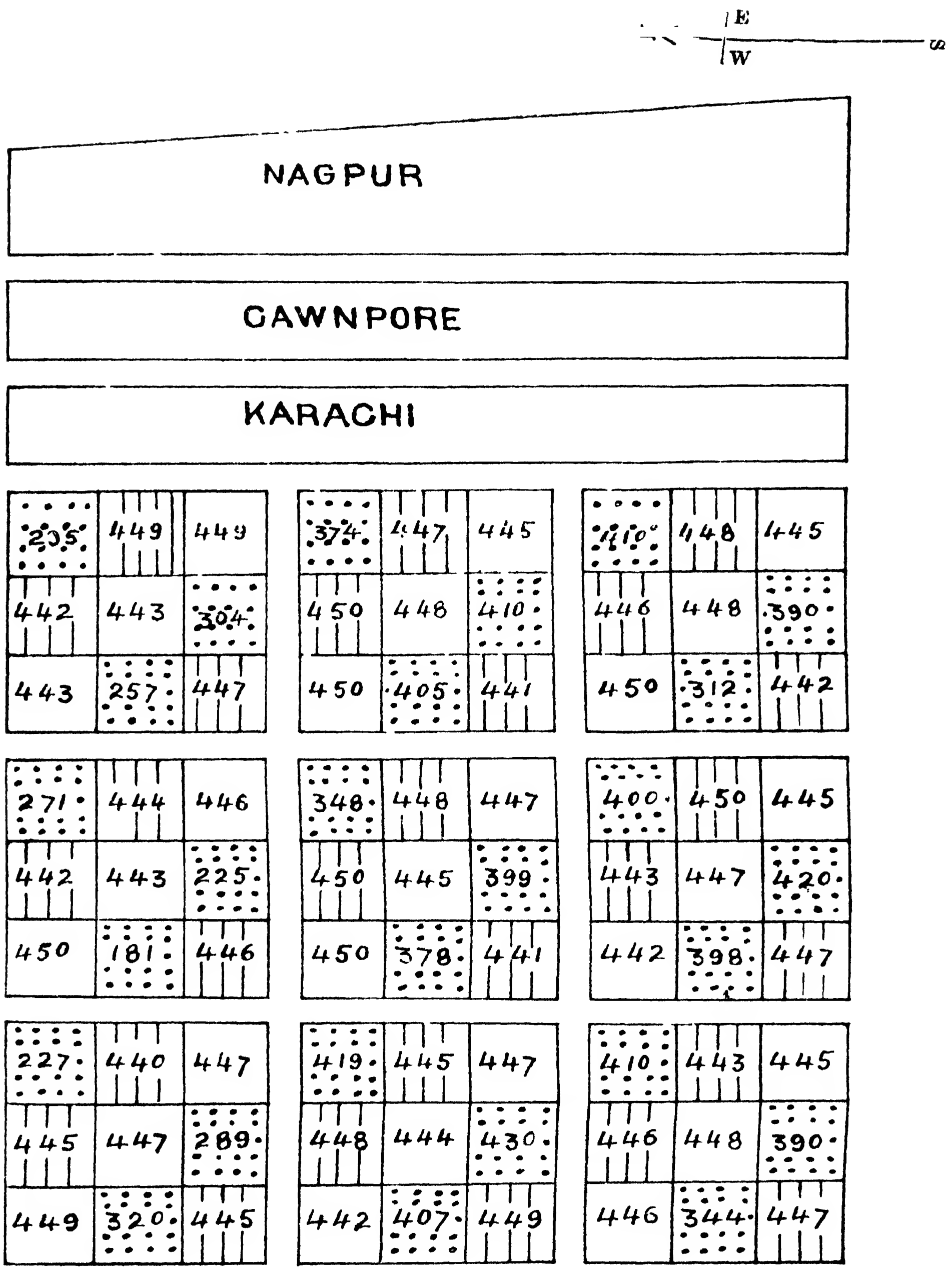
At the end of the season there was a certain number of deaths all over the field even in the resistant varieties, but all these deaths were not due to wilt. Late in the season many of the deaths were caused by an insect attacking the collar and the tap-root.

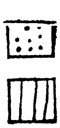
In 1933 the gram-wilt experiments were once again repeated in the same plot of field. Since the two Pusa Types were not doing well as regards yield, being late maturing types, they were not included in the trials of this season.

Cawnpore, Nagpur 28 and Karachi were tried in randomised squares. There were altogether 27 squares, each 15 ft. × 15 ft., for each of these three varieties. Nagpur 28, as in the past, began to show signs of wilt in a couple of weeks from the commencement of the experiment and more and more plants began to die of wilt. Once again it was seen that in one particular part of the field there was a heavy loss due to wilt but very little in the remaining part of the field.

In the strips of field to the east of the randomised squares, Nagpur 28 was badly wilted but, as in the past, the wilted area was confined to one particular part of the strip.

Sketch 4 shows the number of plants on the 2nd of December 1933 in each of the randomised squares where originally there were 450 plants. For the purpose of these trials, the counts of healthy plants taken upto the 2nd of December need only be considered as after this time, on account of the incidence of another disease, to be described later, there were many deaths all over the field. Cawnpore and Karachi varieties were especially susceptible to this disease.




Nagpur 28.

Cawnpore.

SKETCH 4.—A plan of the field where gram varieties were sown in 1933 in randomised squares. The number of plants in each small square at the beginning of the experiment was 450. The number of healthy plants on the 2nd of December 1933 is shown in each square.

From these experiments it is clear that the field, though small (about 1·2 acres in area) is not uniform and that it can be divided in two distinct parts; one part has certain properties which adversely affect the growth of certain varieties of gram, like Nagpur 28; whereas in the other part the same variety can be successfully grown. Whatever be the cause or causes which bring about wilt in gram in the wilt-affected area it is evident that by the normal cultivation methods, such as ploughing, harrowing, bukkharing, this cause or causes do not spread from one part of the field to the other parts.

This suggests the possibility of the cause of wilt of gram not being a pathogene, even though from diseased plants a *Fusarium* has been very often isolated; as already stated inoculations with this *Fusarium* have always failed to reproduce the disease. It is suggested that the nature of the disease may be physiological.

It is not only that in this particular field the wilt-affected area is confined to a definite part of it but, in other fields as well, in Nagpur and outside Nagpur, this is the case, and that there is no general spread of the disease from one field to another or from wilted part of the field to the non-wilted part.

The gram variety called Nagpur 28 is a local selection made by the Economic Botanist to the Government of the Central Provinces. It has been found to be a high yielder but most susceptible to wilt.

The gram variety received from Cawnpore, hence for convenience' sake named "Cawnpore," is very resistant to wilt, but since it was not pure it was given to the Economic Botanist to Government, Central Provinces, for isolation of a pure form and to compare the yield with that of the local strain. In his Annual Report ending the 31st March 1931, Mr. D. N. Mahta, the then Second Economic Botanist, writes "A recent selection No. 515 has been proved to be wilt-resistant and will be utilized as a parent in hybridization work to impart resistance to other strains of high cropping power." This selection No. 515 was from the Cawnpore gram supplied to the Economic Botanist. In his Annual Report for the 31st March 1932, Mr. Mahta states, "A selection was made from Cawnpore gram originally supplied by the Government Mycologist and has been found to be resistant to wilt, but unfortunately the yield of this type does not compare favourably with our selection No. 28, which possesses high cropping power. A cross, therefore, has been made between gram No. 28 and the Cawnpore selection, with the object of combining high yield and wilt-resistant qualities."

Mr. Mahta informs me that the Cawnpore gram was found to be wilt-resistant and "on wilted land actually gave a higher outturn per acre than the local strains. On non-wilted land the yield did not compare favourably with our own selections."

Karachi has proved to be considerably resistant to wilt, though not totally immune, and in yield it does not compare unfavourably with the local strain No. 28. Since, on wilted land it is economically impossible to grow the local strain No. 28, Karachi gram should be tried on an infected field.

Rhizoctonia wilt.—About the middle of December 1933, Cawnpore and Karachi varieties of gram were found dying in large numbers in the gram experimental field where these varieties, along with Nagpur 28, were being tried for wilt-resistance, this disease had not been observed in previous years. Along with these two varieties Nagpur 28 was also affected by this disease, not only in the experimental field but also in other fields of the College Farm. Specimens of gram attacked by the same disease were received from other parts of the Province as well.

In 1934 the disease was not observed, at least on the Agricultural College Farm at Nagpur, though a careful watch was kept for it.

Unlike the physiological wilt, this disease, which also produces a sort of a wilt of the affected plants, does not attack plants in patches confined to particular parts of a field, but diseased plants are scattered all over the field.

Plants suffering from this new type of wilt can be readily differentiated from the physiological wilt described above. The first symptom of the disease is the bronzing of the leaves of one or more branches ; the lower leaves usually are the first to show the change of colour : later all the leaves of the affected branch show the characteristic bronze colour. The leaf-stalk is stiff and slightly turned upwards ; the leaflets stand more or less vertical as if they were taking up the "sleeping" position. The bronze colour of the leaves later changes to yellow and then to brown. The leaflets are prematurely shed ; but the leaf-stalk is persistent and remains stiff and turned upwards. Unlike the physiological wilt-affected plants, the diseased condition is not exhibited by all the branches of the plants ; some of the branches may be normally green and have normally opened leaves, whereas one or more may show the characteristic symptoms described above. Even when the whole plant is affected there is no drooping of the upper tender parts of the plant as in the case of the physiological wilt and the plant looks stiff and dry as if mummified , even when the plant is completely dead and has, remained in the field for a long time the nature of the wilt can be readily recognised. As already stated, in physiological wilt-affected plants there is no shedding of the leaves but there is a drooping of the upper parts and leaves of the affected plant ; and the dead parts have a bleached appearance. In the case of this new disease wilted plants are distinctly brown, and more or less leafless ; the branches stand erect and stiff and leaf-stalks point upwards.

When a diseased plant is sharply pulled up the roots appear to be normal and healthy, but whenever an infected plant is carefully removed from the soil without breaking the roots the terminal parts of the tap-root or laterals they are found to be diseased. They are black or brown in colour and shrivelled. The parts above the diseased portions are white and silvery as in normal plants ; when the root is cut open near the infected part a brown or black centre is readily visible, which does not usually extend much beyond the brown discoloured and constricted parts of the roots,

Of the three varieties grown in the experimental field in 1933-34 Cawnpore and Karachi grams were found to be more susceptible than Nagpur 28.

From the roots of diseased plants a *Rhizoctonia* resembling *R. bataticola* (Taub.) Butl. has been isolated. Diseased plants have not been observed to bear sclerotia; they have been so far found onlyi n cultures. The sclerotia of the *Rhizoctonia* isolated from diseased plants of Karachi variety of gram are much bigger in size than those of the fungus isolated from the infected Cawnpore variety, in shape also there is some difference, the *Rhizoctonia* from Karachi gram has spherical sclerotia whereas the *Rhizoctonia* from Cawnpore gram produces irregularly shaped sclerotia. In cultures on artificial media the two strains of *R. bataticola* show difference in growth as well.

Inoculations with these two strains of *R. bataticola* have not given satisfactory results The inoculations were done in many ways. Plants growing in pots from time to time were inoculated with the fungus at the collar and below the soil surface on the tap-root. The inoculum was placed either on the wounded or unwounded surface. Sterilized soil was well mixed with cultures of the fungi and placed in pots and the seeds were sown in it. Pots were half filled with sterilized soil, and the contents of an Erlenmyer flask in which the fungus was well growing was emptied on the soil surface and the remaining half of the pot was then filled with sterilized soil and then planted with seed. The results were the same in all cases. The plants failed to take the infection. But when pots from each of these series, even many days after they were inoculated. were kept for a few hours in the day for six or seven days at a high temperature, the plants showed distinct signs of infection.

In absence of facilities for maintaining the soil at a definite high temperature the following crude method was employed. The pot in which healthy gram plants were growing was first placed in a jacket of tin and then in a bucket of hot water which was kept out in the open exposed to sun. The temperature of the hot water at the commencement of the experiment was 75° to 80°C. After about three to four hours, when the temperature of the water in the bucket had dropped to about 35° to 40°C., it was replaced by a fresh supply of hot water at 75° to 80°C. Hot water at 75° to 80°C. was renewed three times a day between about 7 A.M. and 4 P.M. The water was not renewed from 4 o'clock in the afternoon till the following morning. The plants were not watered from above but a little hot water was poured into the tin jacket, so that the water slowly percolated through the drain holes at the bottom of the earthen pots. In about three or four days after the commencement of the experiment, to keep the plants at a high temperature, the branches of the plants commenced to show signs of yellowing, but not of bronzing as in the case of naturally infected plants in the fields; the leaf-stalks showed a slight tendency to turn upwards and the leafless to stand more or less erect, but these symptoms were not very marked. The diseased condition was not shown by all the branches; the yellow coloured branches

shed their leaves and dried up. The external symptoms were not exactly typical of those of the naturally infected plants; but there was no doubt that parts of the treated plants were wilting and that the wilting no way resembled the physiological wilt described above. Though the aerial parts did not show typical symptoms of *Rhizoctonia* wilt, the roots of the dying plants in the treated pots showed the same diseased condition of their lower parts as those of the naturally diseased plants.

When the treatment with hot water was discontinued as soon as a plant showed signs of slight yellowing the progress of the disease was checked. The yellowing did not spread but remained confined to the affected branch, the other parts of the plant continuing their normal growth.

Control pots containing ordinary farm soil kept at a high temperature by the hot water method described above showed signs of *Rhizoctonia* wilt. Control pots containing sterilized soil similarly treated did not show any signs of wilt. From some of the dying plants in the inoculated and control pots *Rhizoctonia bataticola* was obtained in cultures. In a few cases *Rhizoctonia solani* was also isolated.

Further work on this disease is in progress and will be described later along with a study of the different strains of *Rhizoctonia bataticola* isolated from different varieties of grams.

REFERENCE

McKerral, A. (1923). *Agic. J. Ind.* **18**, 608.

A NOTE ON THE EXCESSIVE QUANTITY OF IMPURITIES IN WOOL EXPORTED FROM INDIA

BY

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At the request of the Trade Commissioner for India, whilst on leave *ex*-India recently, I investigated, on behalf of the High Commissioner for India, certain complaints received from the English textile industry, relating to the excessive quantities of impurities found in raw wool imported from India.

The facts brought to light by these investigations should be of use to agricultural and live-stock interests throughout India, as well as to exporters of raw material and to marketing officers.

I studied the file commenced in the High Commissioner's office since the complaints originated, and must admit that I left London rather inclined to suppose that manufacturers did not understand that sheep in India are bred under dustier and dirtier conditions than in Europe, and that a somewhat higher percentage of dust in East Indian wool was only to be expected. I had not been long in the textile area, however, before it became necessary to drastically revise these preconceived notions, and—like the Queen of Sheba—I felt " the half was not told me ". When inspecting opened bales of East Indian wool, I certainly had no cause to feel proud of being an officer connected with animal husbandry work in India.

My tour consisted of interviews with members of chambers of commerce, in the textile trades, and visits to mills where East Indian wool is the raw material used. These manufacturers gave me every possible assistance, and were pleased that personal contact with their difficulties was being made by an officer from the country from which the raw material complained was imported. I can safely say that manufacturers are prepared to go on buying and using East Indian wool for as long as they are able to do so economically, and that any fall-off in the demand for this raw material will not be their fault.

The whole trouble can be condensed into one of simple arithmetic. East Indian wool is not purchased by the British manufacturer on account of anything extraordinary in its quality or fibre, but only because it is cheap. If the additional cost of cleaning it brings the price up to that of clean wool produced in the United Kingdom and adjacent countries, the demand for East Indian wool will cease automatically. The margin between these two prices is already a very narrow one and should be regarded as a sign of grave warning in this country.

In the mills that I visited, I was given unlimited opportunity to examine the wool. Large numbers of bales, selected by me at random, were opened in my presence for inspection. I saw the costly machinery and different processes used solely for the purpose of extracting dirt and foreign matter from the wool, and I was shown also the damage done to finished materials by foreign matter, which in spite of these precautions passes into the looms. The worst of all is the admixture of cotton threads in coloured woollen fabrics which show up in a different shade. In one mill I saw numerous employees especially engaged on examining thousands of yards of finished material, inch by inch, extracting with tweezers numerous threads of cotton which had not taken the dye. All this costs money, and hits the pocket of the consumer as well as that of the manufacturer.

From my observations I could only confirm that the East Indian wools imported into England do contain an alarmingly high percentage of dirt, dust, sand, cotton, cotton-yarn and rags, and also vegetable matter in the form of twigs, hay, straw, *bhusa*, etc. I had no alternative but to inform the High Commissioner that the complaints of the manufacturers were fully justified. The amount of sand, dirt and foreign matter in some of the bales has to be seen to be believed.

Almost the whole of the trouble and added expense in which the manufacturers are involved, so far as impurities in the wool are concerned, is from the imports from India. Some of the bales yield only from 70 to 75 per cent of clean wool after the purifying process, a loss of from 25 to 30 per cent. This loss consists of from 15 to 17½ per cent sand and dirt, the balance being foreign matter such as twigs, hay, rags, cotton, yarn, *bhusa*, etc. These, it will be readily admitted, are extremely high figures.

I had access to the records of Messrs J. Crossley and Sons, of Halifax, who are very large manufacturers of carpets and woollen materials, and who are large users of East Indian wool. These records, compiled over a long period of years, show that the amount of sand alone in the bales averages at about 10 per cent of the total weight. As they purchase between four and five thousand bales of East Indian wool annually, a loss of 10 per cent means that a bale of, say, 320 lbs., at the rate of eight pence, comes to approximately £10, of which £1 in value is represented by sand. This is a serious loss, not only to them but to the trade in general (for all spinners of East Indian wool are equally affected), and when the cost of cleaning is added, it is obvious that the increased cost of production eventually falls on the consumer of the finished article and thus reduces his purchasing power.

Leaving the question of the loss to manufacturers and consumers and coming a little nearer home, a matter to be considered seriously is the uneconomic aspect of paying freight from India to England, at wool rates, on this vast quantity of rubbish. The manufacturers are ready and willing to pay higher prices for really

clean wool, as they would save on their present expensive cleaning charges. It should surely be more profitable for exporters to pay freight on bales containing 100 per cent clean wool, than on bales containing 80 per cent dirty wool and 20 per cent refuse.

From what I saw in the textile mills that I visited, it is quite obvious that this wool is not handed over to the buyer in India by the peasant producer in the sad condition in which it reaches England. It is quite true, of course, that sheep in India are reared and sheared under somewhat dirtier conditions than in Europe, and that usually the minimum amount of trouble is taken in cleaning the fleece before shearing. Admitting all this, fleeces cannot carry anything like the quantity of dirt and rubbish I saw in the bales opened for my inspection. Such large quantities of impurities can only have been introduced at the time of baling the wool, so much would fall out of loose fleeces during handling. In the worst instances it is not at all unusual to see several distinct layers of dirt in a bale, showing that it is deliberately introduced whilst the fleeces are being packed into the press.

The excessive quantities of impurities found in bales of East Indian wool for export are, therefore, due to a combination of several causes, *viz.*, faulty methods of washing and shearing sheep, dirty methods of handling, storing and baling fleeces, and a considerable amount of adulteration to increase weights. The responsibility for the latter evils, rests with the middle men and not with the peasants.

It will be realised from the foregoing that the situation is sufficiently serious, and that if India is not to lose her valuable export wool trade, business morality must be so improved as to prevent any adulteration of the raw material.

Sheep-breeding has been commanding a great deal of interest in India during recent years, and large sums of money have been granted for schemes for the advancement of the industry and the improvement of fleeces. It would be nothing short of a catastrophe, if the export market now suddenly failed.

It may be argued that the English market is not the only one available. This may be true, but a long established, well-tried and dependable connection is surely worth something? In new markets (assuming that they can be found), payment may be found to be not nearly so safe and sure as at Liverpool, in these days of fluctuating exchanges and series of economic crises on the continent of Europe. In any case, even new markets have a right to expect the wool they purchase to be clean and unadulterated.

To remedy this evil and improve the quality of East Indian wool for export, the following suggestions may be of use :—

(*i*) The appointment of an "Indian Wool Committee" by the Imperial Council of Agricultural Research, similar to the "Indian Central Cotton Committee".

(*ii*) The education of owners of flocks and their shepherds in—

(*a*) Methods of keeping the fleeces of the sheep clean,

(*b*) Methods of washing sheep before shearing,

(*c*) The necessity of throwing their sheep on to clean ground, gunnies or tarpaulins for shearing.

(*iii*) The instruction of buyers and brokers in the necessity for—

(*a*) Storing the wool in clean go-downs, previously cleared of all dirt and rubbish.

(*b*) The areas round baling machinery to be cleared of all litter, especially rags, cotton, cotton-waste, yarns, *bhusa*, etc., before the wool is brought in.

(*c*) The provision of some simple form of "Shaker" at each baling press, to remove sand and dust from the fleeces before baling.

(*d*) The elimination of the practice of adulterating fleeces with sand and dirt, at time of baling, to increase weight.

(*iv*) The adoption of a system of registration, so that by means of the stencil marks on the bales the place of origin may be easily and quickly identified.

In this connection, I may mention that in the course of this enquiry I discovered that there are both good and bad bales in all consignments. The better bales have as little as from 5 to 7 per cent impurities, whilst very bad ones have as much as 30 per cent.

The bales all appear to be stencil-marked at the place of baling, and I suggested that it might be possible to register these marks and use them to trace the sources of the worst bales. Messrs. J. Crossley and Sons, the firm to whom I suggested this, were enthusiastic about it. They assured me that they were fully prepared to co-operate in such a scheme, by furnishing statistics regarding the condition of the wool and the marks on the bales, at agreed upon intervals. I am quite sure that the co-operation of other mills could be relied upon for similar information. This would deliver a shrewd blow at the root of the trouble, as exporters would naturally refrain from purchasing in areas consistently producing bad bales.

(*v*) Valuable help can also be obtained by enlisting the aid of rural reconstruction organisations throughout India.

ADAPTING THE INDIGENOUS COUNTRY CART OF INDIA TO PNEUMATIC TYRE EQUIPMENT

BY

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In Europe and America, the pneumatic tyre for agricultural and animal transport purposes is long past the experimental stage. Even tractors and agricultural machinery and implements are being shod with pneumatic equipment.

During the past few years, some of the tyre-manufacturing firms have been making a bold bid to popularise this type of equipment in India, and to-day it is not unusual to see, in or near some of the larger towns, an occasional animal-draught vehicle fitted with pneumatic tyres. Some interesting results regarding vehicles so equipped have also been published.

The immense benefit to the country by the general adoption of pneumatic tyres for all forms of wheeled transport can hardly be estimated. The reduction in road maintenance costs alone would undoubtedly be enormous, a saving which could usefully be spent on the construction of new roads.

The reduced draught of vehicles equipped with pneumatic tyres connotes a faster pace and a greater load capacity, thus increasing the " pay-load " per mile. The cushion of air between the vehicle and the road reduces shocks, and so prolongs the life of the vehicle. The roller bearings, running on a steel axle, should give several years more service than the soft iron axle and plain soft iron axle-box of indigenous practice. For these reasons, the maintenance costs of pneumatic-tyred vehicles are much reduced.

Any assessment of the reduction in transport costs, resulting from the adoption of pneumatic tyres, should include the wear and tear on animal power. The improvement of vehicles by conversion to pneumatic equipment should do much to add to the length of the average effective life of draught cattle.

The most serious obstacle to the rapid adoption of pneumatic equipment for transport purposes in this country is poverty. Government departments, municipalities and wealthy haulage contractors may, in course of time, generally adopt this equipment, but there will still be lakhs of privately-owned vehicles on the roads not so equipped.

To bring pneumatic tyres within the reach of the peasant, the price of the equipment will either have to be drastically cut, or its use will have to be subsi-

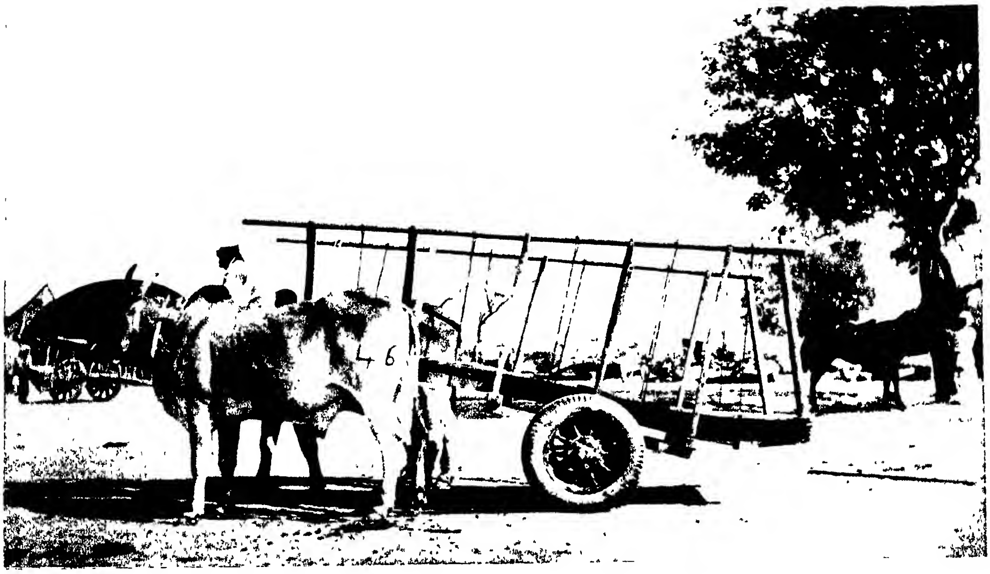

FIG. 1. Country cart adapted to pneumatic wheels by improved design of undercarriage.

dized by local authorities from rural reconstruction funds, co-operative societies and banks or the big land-owners. Co-operation by the tyre-making companies with these bodies seems indicated. Further, the cost of converting an existing vehicle should be very little more than the cost of the new equipment. So far as the average peasant is concerned, new types and patterns of vehicles are at present quite out of the question; it is quite sufficient to expect him to raise Rs. 150 for a set of pneumatic tyres and equipment, without telling him that he will also want a new type of cart, the design and building of which his local carpenters and blacksmiths may know nothing whatever about.

It is, however, frankly admitted, that some extremely good work has been done already, in designing a new type of vehicle suitable for this new equipment. The new carts designed at Pusa [Sayer, 1934] are particularly striking. For the average peasant, such carts seem at present out of the question. The peasant is conservative, and the construction of such vehicles is beyond the scope of the average village *mistri*. The tyre companies, when introducing this new practice into India, should have taken more interest in the adaptation of existing vehicles. Illustrated advertisements showing a new and unfamiliar type of vehicle are unlikely to attract poor mofussil customers. A cheap, but efficient, method of adapting existing vehicles should have been the opening stages of the campaign. New types of vehicles may be left to those who can afford them, until the country generally begins to show encouraging symptoms of "air-wheel mindedness".

In August, 1934, one of the large tyre firms supplied this farm with a set of pneumatic equipment (considered suitable for the indigenous cart) for experimental purposes, the particulars of which are as follows:—

Tyre size	6·00 × 19.
Wheel size	4·00 × 19.
Hub type	Heavy.
Axle	2 in. × 2 in.
Maximum axle load	3,580 lbs. (43 mds.).
Price	Rs. 150.

The suppliers suggested, that to fit these wheels to an ordinary country cart, wooden chocks about 8 in. high should be inserted between the main beams of the cart and the axle. This was of course to compensate for the lower axle line of the cart, due to the small diameter of the pneumatic wheels. Such an arrangement, however, can only be regarded as a makeshift, but it was carried out with one of the standard country carts in use at Hissar (Plate XLI, fig. 1, and Plate XLII, fig. 1). The advantages, weighed against the disadvantages, seemed

insufficient to warrant an expenditure of Rs. 150 on a set of pneumatic equipment. The pros and cons may be summed up as follows :—

Advantages :—

(*a*) Easier draught.

(*b*) Saving of 82 lbs. in the total weight of the cart unladen.

(*c*) Probable future saving in maintenance costs by the longer life of the cart, wheels, axles and bullocks

Disadvantages :—

(*a*) Easier draught and lighter weight not utilised to increase the " pay-load " by—

(*i*) Larger floor area.

(*ii*) Greater cubic capacity.

(Therefore the cost of conversion is not justified on economic grounds.)

(*b*) Load badly distributed, weight being taken by the middle of the axle, instead of by the wheels (Plate XLII, fig. 1).

(*c*) High loads rendered top-heavy owing to the weight being balanced too near the middle of the axle.

Experiments were therefore carried out to remedy these disadvantages by improving the method of conversion. The guiding principles of the work may be summarised as follows :—

(*a*) Weight to be distributed over the wheels and not on the axle.

(*b*) Advantages of easier draught to be utilised for greater load capacity.

(*c*) Cost of the conversion (other than the cost of the pneumatic equipment) to be little or nothing, and within the capabilities of the average village carpenter.

An improved country cart (Plate XL, fig. 1) was produced with a view to meeting these requirements, and the following describes the method employed.

There are innumerable patterns of the country cart in use in India, but their general construction follows certain basic principles. Almost all of them can be converted for pneumatic tyre equipment by the method employed here, with minor modifications where necessary.

Briefly, there are two main beams, either straight or curved, fastened together like a " V ", the joined ends being the yoke or forward end of the cart. At right angles to, and on top of these beams, pieces of timber of different lengths are fastened, which act as distance pieces for the main beams, and also provide the foundation for the sides of the body of the cart. Two of these cross-pieces, known as

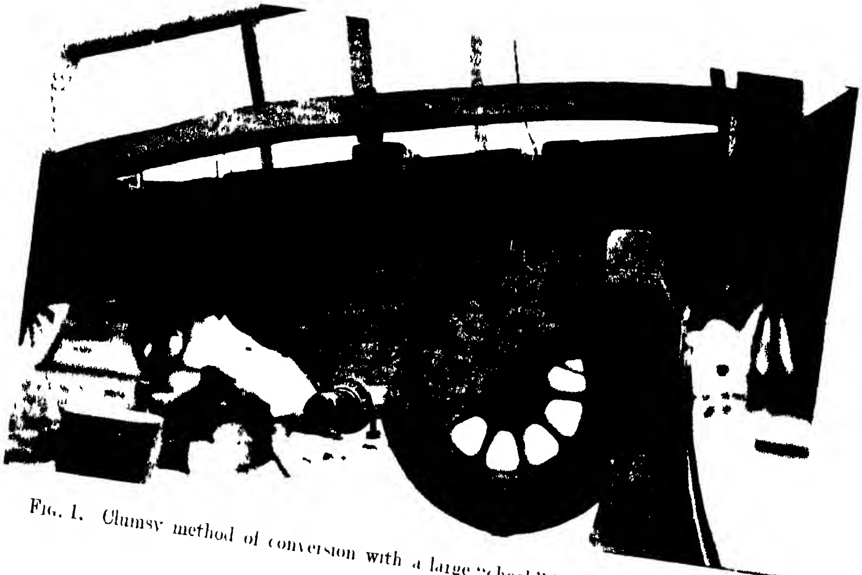

Fig. 1. Clumsy method of conversion with a large "chock" between cart and axle.

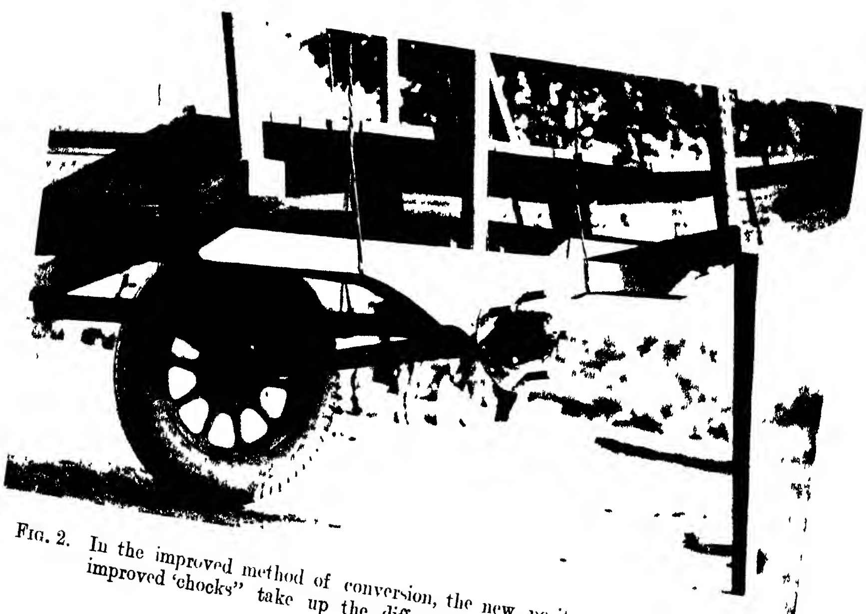

Fig. 2. In the improved method of conversion, the new position of *tikams* and the improved 'chocks" take up the difference in height of axle-line.

ERRATA.

Agriculture and Livestock in India, Vol. V, Part VI.

Plate XXXVI, letterpress, *for* 'Explanation of Plates XXXVI-XXXVII' *read* 'Explanation of Plates XXXVI-XXXVIII'.

Plate XLVIII, fig. 1, *for* 'Guava plantations that were affected' *read* 'A road-side affected tree'.

Page 695, line 6 from bottom, *for* 'mileage' *read* 'milage'.

Page 754, line 6, *for* 'protcin' *read* 'protein'.

Fig. 1. Clumsy method of conversion places the load on the middle of axl

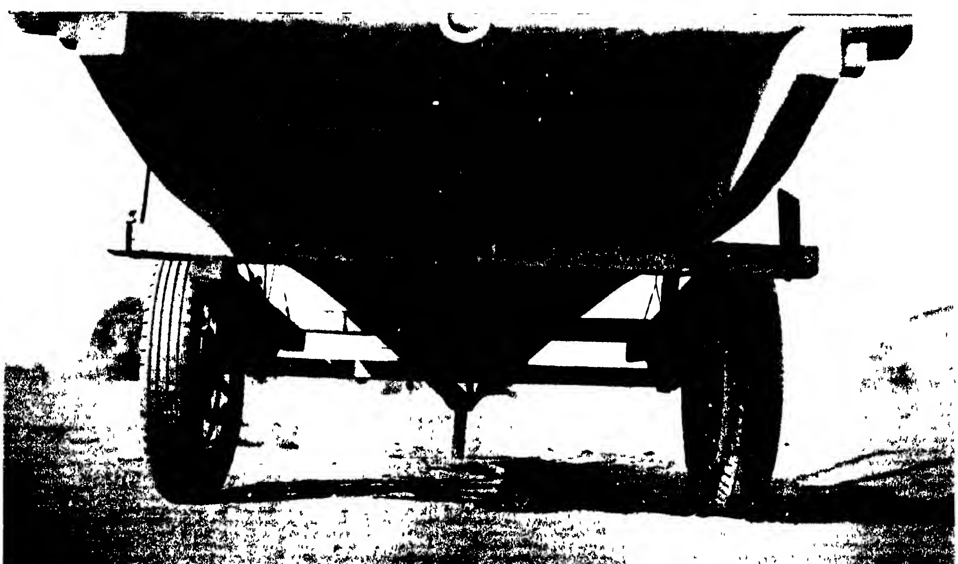

Fig. 2. Re-designed under-carriage distributes the load on the wheels.

tikanis, are longer than the rest. These project beyond the breadth of the cart to support the heavy planks of wood, known as *banks*, which are fixed, with three lynch-pins each, to keep the wheels in position.

The conversion was effected as follows :—

As *banks* are not required to keep pneumatic wheels in place, the *tikanis* were utilised to help to distribute the load evenly between the wheels. They were therefore removed, slightly reduced in length and then re-fixed in their old positions, but beneath instead of above the main beams, thus absorbing some of the difference in the height of the axle-line.

Two new axle-chocks were next designed, and these were made of sufficient depth to absorb the remaining difference in the height of the axle-line (Plate XLI, fig. 2). They were then fastened, parallel with the length of the cart, to the front and rear *tikanis*, and spaced out to the full between-wheel length of the axle (Plate XLII, fig. 2 and Plate XLIII, fig. 2).

Should a peasant decide to have his cart converted to pneumatic equipment by this method, the work of the village artificers would be as follows :—

(*a*) Remove existing wheels, axle, axle-tree, *banks* and *bankalwayas*.

(*b*) Remove *tikanis* and re-fix in the same positions but underneath the main beams of the cart. Cut the *tikanis* to the same length as the track of the pneumatic wheels.

(*c*) Provide four iron bolts and nuts, fashion two new axle-chocks (approximately 1·5 cubic feet of hard wood).

(*d*) Provide four iron bolts and nuts, and two iron plates, each punched with two holes.

(*e*) Assemble the whole on the new axle.

Say, two days' work for the carpenter and his mate, and approximately Rs. 8 for new material, total Rs. 11, from which must be deducted the value of the old material removed from the cart. No provision is made in the above for increasing floor area or the cubic capacity of the cart, on the assumption that the peasant would put off this expense until the body of his cart required repairs in the ordinary way.

Plate XL, fig. 2, shows how the floor area, and the capacity of the country cart reconstructed here was improved, in comparison with a standard country cart. As this improvement was carried out, merely by increasing the distance between the main beams, and increasing the height of the sides of the cart, similar work will demand no alteration in the present technique of a village carpenter.

The following is a comparison of particulars and performance of the standard country cart used on this farm, and the "improved" country cart, fitted with pneumatic equipment :—

Particulars.	Country cart	
	Standard pattern	Improved pattern
Weight unladen	942 lbs.	830 lbs.
Floor area	28·8 sq. ft.	36·5 sq. ft.
Capacity (within the sides)	89·8 c. ft.	159·6 c.ft.
Maximum load (green berseem)	1,312 lbs.	2,952 lbs.
Maximum load (oats in straw)	1,086 lbs.	1,618 lbs.
Draw-bar pull on—		
Pacca road, unladen	100 lbs.	69 lbs.
Pacca road, laden 2,750 lbs.	392 lbs.	336 lbs.
Kacha road, unladen	112 lbs.	78 lbs.
Kacha road laden 2,750 lbs.	448 lbs.	386 lbs.
Ploughed field, unladen	230 lbs.	195 lbs.
Ploughed field, laden 2,750 lbs.	1,050* lbs. upwards	728* lbs. upwards

Surface.	Time factor / Distance miles	Load lbs.	Standard pattern		Improved pattern	
			hrs.	mins.	hrs.	mins.
Pacca Road	10	2,000	4	5	2	58
Kacha Road	10	2,000	4	56	3	40

The same pair of bullocks was used in each test.

*The dynamometer was unsteady on the extremely rough going ontheploughed land.

The method of fixing the dynamometer was similar to the method employed at Pusa. [Sayer, 1934].

This pair of wheels has now been in constant work for over twelve months carrying heavy loads over *pucca*, *kacha*, and ploughed land, and also over *juar* stubbles. So far there has been no puncture and the treads of the tyres shewn no sign of wear.

From the above data it will be seen that in every respect the improved country cart, with pneumatic wheels, is far superior to the ordinary country cart and that the margin of difference in performance is more than sufficient to justify expenditure on a set of pneumatic equipment, *plus* the small cost of converting a country cart. The problem of bringing this pneumatic equipment within the reach of the peasant still remains, however, but it should not be insoluble. It appears to be a simple question of co-operation between the interested parties. By the general adoption of pneumatic equipment, tyre companies will gain by larger sales, local authorities will gain by the reduced costs of road maintenance charges, and the carter will gain by his improved "pay-load" and running expenses. A scheme to bring these three interests together, to their mutual advantage, might well be included in any programme for rural reconstruction.

REFERENCE

Sayer, W. (1934). *Agric. and Live-stock Ind.* 5, 524-533.

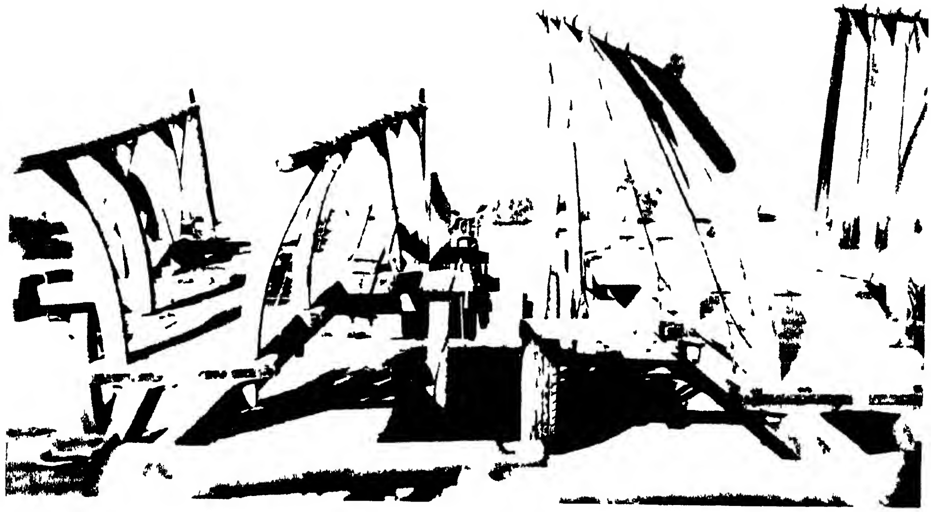

FIG. 1. Country cart and improved country cart from above showing method of conversi

FIG. 2. Country cart and "improved" country cart from below, showing method of conversion.

IMPROVEMENT OF SERICULTURE

BY

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Attempts are now being made to improve sericulture in India. It is proposed in this article to discuss the lines on which these efforts should be directed.

Inter-dependence of the different branches of the silk industry

The two main divisions of the industry are: (I) production of the thread or raw silk industry and (II) utilization of the thread or manufacturing industry.

The raw silk industry is popularly spoken of as sericulture but really consists of: (*A*) sericulture proper, *i.e.*, rearing of silk-worms to produce cocoons and (*B*) reeling of the cocoons into thread or raw silk. The various branches of a well-organised raw silk industry are shown below in a tabular form—

I. Raw silk industry.

(*A*) Sericulture proper, *i.e.*, rearing industry, comprising:

1. Mulberry cultivation, as—
   - (*i*) bush from cuttings.
   - (*ii*) bush from roots
   - (*iii*) bush from grafts
   - (*iv*) trees from grafts

   (ii)–(iv): based on production of seedlings and grafts.
2. Production and supply of eggs (seed).
3. Rearing of worms.
4. Disposal of cocoons.

(*B*) Reeling industry comprising:—

(1)
- (*i*) purchase of cocoons.
- (*ii*) stifling cocoons.
- (*iii*) drying cocoons.
- (*iv*) storing cocoons.

(ii)–(iv): Being developed as a separate industry in Japan.

(2)
- (*v*) sorting cocoons.
- (*vi*) reeling and re-reeling.
- (*vii*) testing the raw silk as it is produced in order to be able to maintain the standard.
- (*viii*) dressing and packing the raw silk.

(3) (*ix*) disposal of the raw silk through conditioning houses which have to carry out two preliminary processes, *viz.*, (1) grading, *i.e.*, testing quality and making out certificate of the grade in which it falls, and (2) conditioning.

II. The manufacturing industry comprises:—

1. Throwing of the raw silk through certain processes in order to make it fit for use in manufactures.
2. Actual manufacturing, *i.e.*, weaving, knitting, embroidery, etc.
3. Finishing the manufactured stuff, *i.e.*, washing and calendering.
4. Dyeing of the yarn before weaving or of the manufactured stuff.
5. Printing.
6. Disposal of the manufactures—done after conditioning, *i.e.*, inspection and passing for market and export.

All these are arranged for separately and as separate industries or under separate organisations.

The raw silk industry supplies the raw material for the manufacturing industry and flourishes only when it produces the material in every way suitable for the latter. Because Japan has always endeavoured to meet the requirements of the American weavers, she has been able to capture the whole American demand for raw silk and finds a ready sale for raw silk in all countries.

Production of suitable raw silk is possible when suitable kinds of worms are reared under sanitary conditions, with suitable food and the resultant cocoons are reeled in a suitable manner. This is one whole process. In primitive and unorganized sericulture the rearers are their own reelers. But production of large quantities of uniform raw silk is not possible unless reeling is carried out in central factories or filatures. Therefore, in well-organized sericulture, reeling is organised as a separate industry. Also, on account of the peculiar liability of silk-worms to a hereditary disease, *viz.*, pebrine, production of seed has to be carried out in a special manner under supervision so as to ensure the health of the future worms. Seed production has thus come to be organised as a separate industry.

Mulberry accounts for about sixty per cent of sericulture proper. It is usually grown by the rearers themselves but in some places by others who sell the leaves to rearers. In Japan production of seedlings and grafts is a separate industry in the hands of farmers who sell seedlings and grafts to growers of mulberry for worms. Everything depends on the provision and supply of leaves. If leaves are available actual rearing of worms does not take more than about three weeks to a month. Given the best worms but insufficient or bad leaves, the result will be poor cocoons. The importance of this has been stressed by all who have studied the question of the improvement of sericulture in India but hardly any attention has been paid to it. In Japan there is a mulberry department in each sericultural experiment station. The Imperial Experimental Station has for its mulberry department three experts, three assistant experts and six assistants. Forty-eight prefectural experiment stations have each a mulberry department. To give details of one, the Kumagaya Station has for this department one expert,

five assistant experts, seven assistants and ten casual assistants. The experiment station staff maintains demonstration mulberry in each country. The three sericultural colleges and the four universities with agricultural faculties have each a mulberry department with sufficient staff. The staff of the 343 controlling stations, through their supervision of and advice to about 64,000 nursery-men, help in the improvement of mulberry and cultivation processes. Subsidies are given for improvements in various ways, improved seeds and varieties are distributed and lectures are given on improved processes. About 385 mulberry varieties have been studied and, out of them, about nine are selected and are grown in different places according to suitability to climate and soil and quality of leaves.

The best cocoons badly reeled are no better than bad cocoons. Therefore, proper reeling, so as to produce good quality raw silk, must be attended to at the same time as production of cocoons. Given mulberry and seed, cocoons are produced in about a month and require to be reeled. Reeling cannot wait and cocoons are of no use unless reeled into thread. Apart from efficient reeling, treatment of cocoons before reeling may interfere with their reeling quality as well as the quality of the thread produced. First of all the worms inside require to be killed or stifled so that they may not cut out and render the cocoons useless for reeling. Then the cocoons require to be thoroughly dried so that they may not get spoilt while waiting in the store before reeling. Drying in all advanced methods of sericulture is carried out by application of heat. In Bengal and other places in India the practice is to stifle and dry them in the sun. Apart from the poorness of the Bengal cocoons, to the writer there seems no doubt that this was and is one of the main reasons for the bad quality of the raw silk produced in Bengal. Repeated experiments have proved that the best Maymyo hybrid cocoons which are much better than Bengal ones, when dried in the sun, did not reel well even when fresh, while the same cocoons dried with heat without exposure to the sun not only reeled well but retained their reeling quality fully even after eight months in the store. Sorting of the cocoons must also be attended to if high class uniform raw silk is to be produced. Sericulture, therefore, cannot stop at provision of good seed or good mulberry or good rearing but must also take care to have proper reeling. The whole must be attended to at the same time if satisfactory progress is desired.

RACES OF WORMS

The cocoon from which the raw silk is obtained is the main thing and forms the basis of the industry. A good cocoon will give good raw silk and the more its silk content the more the raw silk obtainable from it. Generally speaking, univoltine or one-brooded races, *i.e.*, those which breed only once in the year, produce superior cocoons. Multivoltine or many-brooded races produce inferior cocoons. But the races of worms which have been reared in different countries have been determined mainly by climate. This is why multivoltine races have come to be reared

in tropical countries, *viz.*, South China, Indo-China, Siam, Burma and India. Univoltine worms are reared in North China, Japan, France, Italy and other places. In India itself univoltine races are reared in Kashmir and the Punjab. But the present requirements in all other places in India are of multivoltine races. All rearers in these localities at present prefer multivoltine races for various reasons.

On account of the inferiority of multivoltine cocoons, attempts are made in every country to improve them by crossing them with univoltine ones. Such efforts have been made in the past in all countries and the present multivoltine races are hardly pure anywhere. That the Mysore race is such a hybrid has been proved by the occurrence several times of this type cocoons in the hybridization trials at Maymyo. The Bengal Nistari and Chotapolu and similar races occurring in Assam and Burma are also presumably hybrids produced long ago and therefore degenerate.

That the existing multivoltine races can be improved by hybridization is a common experience in all countries. South China and Indo-China at present rear such improved hybrids. Elaborate hybridization was carried out in Siam by Toyama. In India in recent years hybridization has been carried out at Pusa, in Bengal, in Mysore, in Madras and by the present writer in Burma. The Pusa and Bengal experiments were not carried to the point of securing fixed hybrid multivoltine races. In Burma, as a result of cross-breeding between Italian univoltine and indigenous multivoltine races since 1922, several fixed hybrid multivoltine races have been obtained with different types of cocoons, *viz.*, Nistid, Nistam and Nismo with yellow cocoons, Itab. I and II with yellowish cocoons, and Maymyo white and Maymyo green with white and greenish (Mysore type) cocoons, respectively. These are multivoltine now and are being reared in the same way as the old indigenous multivoltine races. The Burma Department has also been maintaining a pure Italian race for six years. Repeated trials have shown that the following results are possible with the various races with which this department is dealing—

Name of race	Silk content in one cocoon in grains.	Filament length in one cocoon in yards.
Pure Italian	4—4½	700—800
F_1 cross (Italian × Maymyo fixed hybrid)	3—3½	600—700
Maymyo fixed hybrid multivoltines (Italian × indigenous race)	2—2½	400—600
Compared with the above the indigenous races in Burma, Assam, Bengal and Mysore	1—1½	150—300

Some of the existing indigenous races produce so fluffy cocoons that the weight of silky substance in them does not adequately show their very inferior nature as regards yield of raw silk. Some of them can be hardly reeled into good

thread and on good machines and can be dealt with only by primitive machines which work the fluff and everything into a coarse uneven thread.

To all who have studied sericulture in India, improved races of worms producing improved cocoons have appeared as of the first importance. N. G. Mukherji went so far as to suggest adoption of univoltine races in Bengal. Lefroy's recommendation for all multivoltine rearing areas was for adoption of better races then (but no longer) existing, *viz.*, Madagascar and Cleghorn's. Much better races are now available as explained above.

It seems proper to mention here the results of attempts at rearing Italian and F_1 crosses mentioned in the statement above at different places in Burma. On the ordinary bush mulberry grown from cuttings Italian worms thrive up to the fourth stage and unless fed with mature leaves of trees in the last or better in the last two stages, they fall victims to grasserie disease so badly as to nullify the whole rearing. The same is the case with F_1 crosses, especially when the mother is Italian and to a less extent when the mother is a Maymyo hybrid. Success with these improved races does not seem to be impossible but seems possible only with proper type of food.

That all avenues should be explored for successful rearing of superior races of worms in all places is evident and is a question of the first importance in the interest of sericulture in India. The product of poor cocoons like the indigenous ones can never be expected to compete with that of superior races now reared in other countries. Therefore, efforts should be made to have such food grown as will enable high class worms to be reared. In Japan the worms are reared almost wholly on bush grown in fields. But these bushes are grown from grafts and their stem is allowed to mature and thicken. Therefore these bushes are really trees kept low and the leaves obtained from them are of high quality. Such grafts can be got ready within three years, while trees may take double or more than double this time.

It seems also proper to record the experiences in Burma in importing univoltine eggs from foreign countries. Eggs imported as pebrine-free from recognised seed-producers and experimental stations in France, Italy and Japan invariably developed pebrine in this country and infected the stock of worms at Maymyo, involving a good deal of trouble in eliminating the disease again. The imported worms had on several occasions to be given up. However, a few strains of worms obtained on the recommendation of Professor Pigorini, Director of the Sericultural Station, Padua, proved to be better though not entirely free from the disease and these worms, after complete elimination of the disease, are being maintained for the last six years. They show no signs of deterioration as is evident from the cocoons produced in successive years. This has been possible with proper hibernation with the help of a refrigerator and rearing with proper kind of food. If rearers can be helped to grow proper kind of food, rearing of high class univoltine

or F_1 cross worms appears to be quite practicable. The production and upply of eggs and hibernation, and treatment of eggs as necessary, must be carried out departmentally or through trained egg-producers. Until these conditions are fulfilled rearing of univoltine or F_1 cross worms is better not introduced among the general rearers in the present multivoltine rearing areas. For the present, worms of the type of the fixed Maymyo hybrids produce cocoons yielding suitable raw silk. They are capable of further improvement which should be attempted and this work should be carried on continuously.

Production and supply of seed (eggs)

In order to control the hereditary pebrine disease, egg-production in Japan is carried out entirely through Government agency, with the help of licensed egg-producers, and production of eggs by rearers themselves is prohibited by law. In France no legal prohibition exists against rearers producing and using their own eggs, but there are adequate arrangements for production of examined eggs by licensed egg-producers and in order to encourage the use of examined eggs a bonus is given by Government on every kilogram of cocoons raised from examined seed purchased from a recognised seed-rearing establishment. In Italy, too, rearers can produce and use their own eggs but practically all rearing is done with examined eggs from licensed egg-producers.

The use of eggs free from pebrine is essential for successful sericulture. The practical method of securing this, evolved by Pasteur, is followed in all countries. Each mother moth is isolated and her eggs examined under microscope. The eggs of moths showing no pebrine are selected and are known as cellular seed. For maintaining the stock of worms in a pebrine-free condition cellular method of selection is necessary but it becomes too expensive in the case of eggs for raising cocoons for reeling.

In no country, therefore, general rearing of cocoons for reeling is done from cellular seed. The seed obtained as first generation offspring from cellular stock, and known as industrial seed, is quite sufficient for general rearing and gives quite good results provided rearing is done properly. In all places only about ten per cent of industrial seed is examined and in Japan it is passed even when having a trace of pebrine, *i.e.*, less than one per cent.

Although so much stress has of necessity to be laid on pebrine on account of its hereditary nature and baneful influences, this is not the only disease from which worms suffer. The other diseases are flacherie, somewhat like human diarrhœa and cholera; grasserie, somewhat like human jaundice, and muscardine, a very contagious and fatal fungal disease. These diseases are closely connected with quality of food, climate, humidity, ventilation and, above all, treatment and handling of the worms during the entire period of their larval life. Even when

freedom from pebrine is guaranteed, exposure of eggs to highly fluctuating temperature renders the future worms unhealthy and liable to flacherie, which is also brought about by unsuitable food, irregular feeding and high temperature. Grasserie is similarly connected with food and want of ventilation and high temperature. A humid atmosphere favours muscardine. Again, the best varieties of worms though reared in the proper season may fail or may produce poor cocoons when not fed with sufficient and proper food or treated badly or kept under insanitary conditions.

Microscopic examination provides against the hereditary pebrine. Worms from thoroughly pebrine-free seed, however, can and do contract the disease when reared in an infected place, or with infected appliances or in company of infected worms. Therefore, in order to ensure the health of the worms, it is not enough to lay emphasis only on examined eggs but, at the same time, education of the rearers in proper methods of rearing is also desired. In this connection the following quotations from the Report [1922] on Silk-worm Diseases, by Dr. A. Pringle Jameson, who was especially engaged to investigate these diseases by the Government of India are, significant: " Disease, I have said, can be to great extent controlled, but only, be it noted, under certain conditions. The practice of using examined seed must be made universal and improvement must be effected in the rearing houses, in the rearing methods and in the cultivation of mulberry". " There are two great points to be aimed at: (1) the production of sound seed, and (2) the improvement of rearing. Both are equally important, and to attain one without attempting the other would give us much less than half the battle. The two should go hand in hand ".

Maintenance of stock in pebrine-free condition and supply of pebrine-free seed to rearers does not require research so much as organisation. The whole process has now been reduced to a routine and if an efficient organisation is set up to follow the routine, results are guaranteed.

That it is possible to maintain stocks of both multivoltine and univoltine races of worms in absolutely pebrine-free condition and that industrial seed from such stock gives quite satisfactory results in the hand of rearers has been the experience in Burma over a sufficiently long period.

That pebrine-free seed alone will not help the industry will be evident from the history of sericulture in Bengal where for about the last fifty years the sericultural department has devoted all its energies to nothing but supplying examined eggs and yet the record there is one of continued decadence and it was during this period that all the large reeling concerns in Bengal closed down, while Japan and other countries made tremendous progress. The primary necessity of Bengal is improved cocoons.

Reeling

Uniform standardised raw silk is the demand of the market and production of a standardised thread is possible: (1) when reeling is carried out at a central place

or filature under supervision, (2) by skilled reelers, (3) with proper machinery and (4) accompanied by testing to be able to see whether the standard is being maintained. Where cocoons are available for sale any small or large capitalists can set up small or large filatures, when they see the actual process and machinery at work and the method of running a reeling concern, *viz.*, drying and storing cocoons, sorting, reeling, re-reeling, testing and dressing the raw silk. Centralised reeling with purchase of cocoons from rearers is to be aimed at, but it should be noted that much of reeling will continue to be carried out as a home industry even though factory reeling is arranged for. It is so even now in Japan (Imperial Council of Agricultural Research, Scientific Monograph No. 8, pages 21-33). In all places reeling has got to pass through the home phase. Bengal and Mysore are still to a very great extent in this phase. Bengal fell back into it practically wholly after the closing of the large filatures. Burma and Assam are wholly in this phase. A sericultural department in such places is always called upon to arrange for reeling immediately after cocoons are produced. A suitable and cheap home-reeling machine is therefore urgently wanted. In Burma the Japanese treadle machine, *Ashibumi*, has been introduced and is liked by all rearers. As regards filature machinery, the writer has seen the French, Italian, Bengal and Japanese ones and unhesitatingly recommends the Japanese. It is simple and cheap and at the same time quite efficient. Cheap filature machinery, complete and set up, cost about yen 70 per basin doing five to seven threads at a time. Re-reeling followed in Japanese methods may at first seem as an extra process and therefore adding to cost. But re-reeled silk is the demand of the market and without re-reeling the product will be hardly acceptable. Japan had at first adopted the French and Italian method of carrying out reeling in one process without re-reeling. But afterwards she found out that it paid to re-reel and altered the machinery at great cost, making re-reeling a necessary part of reeling operation. An up-to-date filature requires (*i*) water and (*ii*) steam-supply to reeling basins and (*iii*) power to turn reeling and re-reeling machinery. When electricity is available the question of power is easily solved. But it is desirable that filatures should be established in rural areas. For this purpose, at the present stage, probably steam power generated by coal has to be worked out. Such a complete model filature will enable capitalists or companies to start filatures where required.

In connection with reeling it will be necessary to attend to simple cocoon-drying chambers and drying processes and methods of storing cocoons.

Conditioning and grading of raw silk

Silk being hygroscopic absorbs moisture from air and its weight varies according to atmospheric humidity. Therefore buying and selling are done on conditioned weight, that is, absolutely dry weight plus 11 per cent of this weight.

Raw silk has to be taken through throwing processes before it is woven or knitted. In order that it may work through throwing machinery with ease and without trouble and in order that uniform and defectless woven and knitted goods may be produced, it is demanded that raw silk thread :—

(1) should be uniform in thickness,

(2) should not break in unwinding and

(3) should not have defects, such as slugs, knots, nibs, hairiness, loops, cork-screws, etc., which impede processes and show in the finished goods.

Raw silk is, therefore, now-a-days subjected to various tests before transactions in it are completed. The most important tests are those of :—

(1) evenness, to find out uniformity of thickness of the thread and

(2) cleanness and neatness, to find out freedom from defects.

Tests also are carried out to find out :—

(3) breaks in unwinding

(4) deviation or variation in the thickness of the thread in a lot

(5) average thickness of the thread in a lot

(6) tenacity or strength of the thread and its elongation or elasticity and stretch before breaking

(7) cohesion of the component filaments of the thread and

(8) boiling-off to determine the proportion of natural gum in the thread.

Hardness, softness, colour, lustre, etc., of the thread are determined by sight and touch. As a result of these tests which are applicable to a bale of 133⅓ lbs. or to a lot containing ten such bales, the raw silk in the bale or lot is placed in one or other of different grades at present recognised in different countries. An attempt is being made to arrive at an international system of grading or classification of raw silk and is nearly successful.

Japan has recently passed a law that all raw silk for export must be tested and go under a certificate issued after the test. China also in many cases has arranged for similar certificates for export raw silk.

As in all commodities, the essential requirements in raw silk are quality, uniformity and availability in quantity. Through research, experiment, organisation and adoption of improved methods and machinery, Japan has met these requirements and she is to-day the largest producer and exporter of raw silk in the world.

THE REQUIREMENTS FOR IMPROVEMENT

It will now be evident that the requirements for improvement are :—

(1) improved races of worms reared from

(2) healthy, *i.e.*, pebrine-free seed (eggs) with

(3) good, sufficient and proper food under

(4) conditions which will prevent infection from pebrine and loss from other diseases, *viz.*, flacherie, grasserie and muscardine and also from the parasitic fly where it occurs and

(5) the resultant cocoons reeled in a proper manner so as to produce a uniform standardised raw silk.

These five points are inter-dependent and must be attended to at the same time in order to be able to bring about improvement in the sericultural industry. The importance will also be evident of the recommendations of the Tariff Board, a body of non-technical investigators who so ably carried out an exhaustive enquiry. The recommendations are summarised below :—

1. As improvements in technical methods can only be effected by research, continuous research to be carried on, on all-India as well as provincial basis, into (*a*) the best varieties of mulberry, (*b*) the best yielding races of silk-worms and (*c*) the best methods of reeling for the export as well as the home market.
2. The work carried on according to 1 in different parts of India to be co-ordinated by an Imperial Sericultural Committee, which is to be a controlling centre for sericultural practice and to serve as a clearing house for sericultural ideas.
3. In order to enable this committee to perform these functions satisfactorily it is to be assisted by a whole-time Imperial Silk Specialist.
4. Provincial sericultural bureaus to be formed to popularise the results of research.
5. Bounties or subsidies as in France and Japan are to be given as a more powerful agency for improving the industry than a general scheme of protection.
6. Means to be adopted for guaranteeing supply of disease-free seed and if necessary legislation to be adopted to prohibit any other seed.
7. Sericultural education is to be organised for spreading knowledge of improved technical methods.
8. Improvements in marketing organisation to be effected by—
   (*a*) organisation of co-operative societies or other associations.
   (*b*) adaptation of raw silk produced to the needs of consumers, *viz.*, hand-loom weavers by means of better reeling and re-reeling.
   (*c*) organisation of cocoon markets.
   (*d*) organisation of silk-sale departments in and outside India.
   (*e*) arrangements for conditioning and testing for grading export silk and, if possible, all silk before sale.
   (*f*) standardization of weights and measures for removing the present handicap to trade.

9. Better means to be adopted for collection of statistics pertaining to the industry.

Of the recommendations all excepting probably 5, 8 (*f*) and 9 are inter-connected and are necessary to be attended to at the same time for the welfare of the raw silk industry. They should be considered together. Attention to any one of them alone is not sufficient.

As regards provision of sericultural education, it seems to the writer that so far as actual rearers are concerned better results than provision of sericultural training in schools can be obtained under the existing circumstances by establishment among rearers of demonstration centres, however small, for showing proper methods of mulberry cultivation and rearing and also at the same time for distributing better mulberry and examined seed. The children of the main body of rearers do not attend school. The writer's experience in Burma has been that preaching through pamphlets or talks or even training a few rearers has not done what one demonstration among rearers has achieved in the way of introduction of improved methods of mulberry cultivation and rearing.

As regards legislation to enforce the use of only examined seed, it will appear that legislation can hardly be enforced in many places, such as remote villages. In this case the analogy of Japan will not hold good. In Japan the rearers are educated and, moreover, used to guidance by law in so many ways and rearing is done of univoltine or bivoltine races only in particular seasons. In India the worms are multivoltine and can be reared any time in the year and production and maintenance of the seed is so easy and can be carried out so secretly that the temptation to keep one's seed and rear it when there is leaf-supply can hardly be overcome by the illiterate and poor rearers, especially when they can avoid payment for, or the trouble of going to a distance to procure, examined eggs. It will be practically impossible to enforce legislation wholly. On the other hand, much better results can be obtained (*i*) if the rearers can be convinced that they get much better results from eggs supplied from a Government or recognised nursery and especially when such seed produces superior cocoons and (*ii*) if the seed is rendered available easily. The writer is convinced of this from his experience of actual work in Burma. Lefroy also considered legislation not practicable for the purpose.

The Tariff Board in their report (pages 35-36) have given reasons for, and emphasised the necessity of, a co-ordinating organisation on all-India basis, and recommended the formation of the Imperial Sericultural Committee as part of the Imperial Council of Agricultural Research. The Sixth Industries Conference recommended this Committee to form part of the Advisory Council of the Industrial Intelligence and Research Bureau. It is evident that this Committee should be able to advise on all technical matters connected with the sericultural industry. Otherwise its formation and existence are not justified and the Tariff Board rightly leaves to this Committee details of technical matters pertaining to biology and technical processes relating to reeling, re-reeling, conditioning and grading.

The Sericultural Committee should be formed primarily of persons who have the necessary knowledge and experience of sericulture and can very properly be leavened with inclusion of members who, although not possessing technical knowledge, can take broad general views. The Committee should have as members :—(1) persons in charge of sericultural work being carried on in different parts in India and representatives of (2) reelers, of (3) throwsters and (4) co-operative or other associations dealing with sericultural products, besides others who may be considered necessary. This committee will meet periodically and cannot be expected to be conversant with the progress of conditions prevailing in the whole of India or to be in touch with details on which so much depends, and in order that it may function properly, the recommendation of the Tariff Board for a whole-time all-India silk specialist who will study and be conversant with actual workings, needs, progress and development of different branches of sericulture throughout India is very wise and should be given effect to, along with the formation of the sericultural committee as forming a part of the Committee. Unless expert advice be available, the advisory council of the Industrial Intelligence and Research Bureau cannot be expected to be able to do its duty towards sericulture.

How the desired results can be brought about

There is immediate necessity for an organisation or research and experiment station to undertake and carry on :—

(1) biological research with different races of worms, with the aim of evolving improved races and improved methods, so that already known possible better and superior races can be reared. There are many connected problems awaiting solution, for instance, correlation of food to the habits of a race and to quality and quantity of silk in the cocoon, of ventilation to life of the worm, of rearing methods to incidence of diseases, etc.

(2) research on mulberry which, though forming about sixty per cent of sericulture and having intimate connection with superior worms, is wholly an unworked and unknown item in India yet. Study, selection, improvement and successful cultivation of mulberry is an important factor for success and improvement in sericulture.

(3) research on reeling. Though improved machines are available in Japan and should be adopted at once, some work will be necessary for their adaptation to local conditions. There is also work required to be done in connection with treatment of concoons before reeling such as sorting, drying and storing. These and other methods connected with and actual organisation of, the reeling industry require a good deal of work.

(4) testing of quality and conditioning which are necessary adjuncts in order to be able to gauge the progress of work indicated in the preceding three items.

The organisation of a station carrying out the above work is the necessary foundation for improvement of the sericultural industry. It is best located in a large rearing area and the conditioning and testing department may serve the trade in raw silk, at least at the beginning. Similarly, the reeling department may serve as a model. The all-India silk specialist spoken of above, if appointed, should be in the closest touch with this organisation.

For actual work in a rearing area there should be :—

(1) a station for (*a*) maintenance in absolutely disease-free condition stocks of worms which are approved as suitable for distribution to rearers and (*b*) experiments in mulberry which will at the same time serve the purposes of rearing at the station.

(2) industrial seed-rearing stations, where necessary, among groups of rearers, which will rear and supply seed to rearers and serve as demonstration places in methods of rearing and mulberry cultivation.

Unless there be the advantage of the main experiment station there should be in addition to the above :—

(3) a small model filature combined with throwing. In some places for instance in Burma, the raw silk is placed in the market by Chinese exporters as a thrown yarn. In order to be able to compete with it on equal terms, the locally produced raw silk should be marketed in the same condition.

METHODS OF SELECTING SUGARCANE SEEDLINGS (AS ADOPTED AT COIMBATORE)*

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I. Special interest of Coimbatore methods

The methods of selecting seedlings adopted at Coimbatore have perhaps special interest. The Coimbatore Station situated in tropical India had, as its main function during the first fifteen years of its existence, the breeding of improved seedlings for sub-tropical India, where growth conditions are so different from Coimbatore. This was because the bulk of the sugarcane area in India is in sub-tropical North India where, for climatic reasons, it was not possible to locate the breeding station. At the same time the types of canes grown in North India were notoriously poor and needed urgent improvement.

A partial analogy to the above is found in certain Java and Demerara seedlings which, though not of much use to their country of origin, have yet benefitted the sugar industry of sub-tropical Louisiana. There is, however, this difference, in the above instances success was accidental, in the case of Coimbatore the plan of work was deliberate and unavoidable. That the Coimbatore breeding work has borne fruit in sub-tropical India is now well known ; it is these Coimbatore canes that have rendered possible the recent renaissance of the Indian sugar industry.

II. Brief review of the important stages in the breeding work

(a) *The hybridization programme*

To understand the Coimbatore methods of selection it is necessary to narrate here very briefly the important stages in the breeding work there. In subsequent paragraphs attention will be invited to such features as are considered to have contributed to its success.

Each year a certain number of experimental crosses are made and small numbers of the hybrids grown for a whole year to get ideas about the types of seedlings resulting from them. This has resulted in the compilation of lists of suitable and unsuitable parents and their combinations and has yielded indications as to which parents should be employed for securing particular results.

* Originally prepared for a symposium on the subject at the Fifth Congress of the International Society of Sugarcane Technologists (August, 1935).

DISTRIBUTION OF SUGARCANE AREA IN INDIA

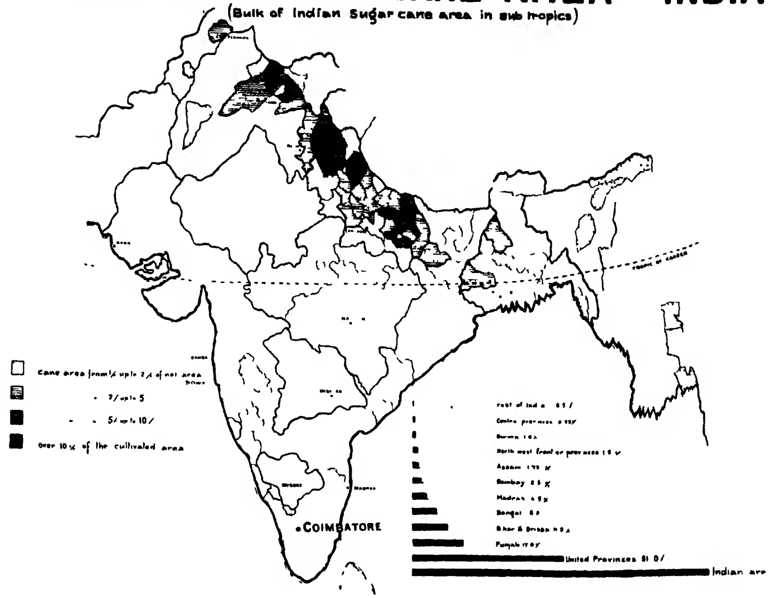


FIG. 1 Coimbatore (in tropical India) has successfully bred improved seedlings for the main sugarcane tracts of Sub-tropical North India.

FIG. 2. Seedlings from promising combinations are raised on a mass scale—sometimes over one hundred

Certain of the over twenty different types of *Saccharum spontaneum* collected at Coimbatore.

Hybridizations which have shown promise of yielding the desired types are repeated on a mass scale in a subsequent year to try and fully exploit the possibilities from the particular cross. This work often necessitates the planting of the mother-parent in special plots, during the previous year, removed from possible access of undesired pollen, and the bringing to them, at the right time, of large numbers of artificially-rooted plants or the pollen of the desired father-parent.

(b) The seedlings stage

Large numbers of seedlings—sometimes over 100,000—are raised from such crosses and the seedlings planted in beds, 12 in. × 6 in. apart. Such of these as are satisfactory in vegetative characters, healthy vigorous growth being specially important, are picked out, planted in the ground with the same spacing here as in ordinary cultivation, and grown for a full year. Juice analyses are made of only such canes as are satisfactory in vegetative characters, such as growth, habit and type of canes; the rest discarded. Experience has shown that, however rich a seedling may be, it does not ultimately prove suitable in cultivation unless it possesses satisfactory vegetative characters.

(c) Seedlings subsequently propagated from cuttings

Selections from the above seedlings are then multiplied from cuttings and planted in short rows, each 20 feet long—the number of rows depending on the available material which again depends upon the stage of selection where the new canes have reached. The local or standard canes from the tracts, against which the new selections have to be made, are planted at more than one place in these plots and treated and studied in the same way as the new canes in all respects and at every stage.

Besides recording notes on germination and habit, the new canes are periodically studied in order to estimate vegetative growth and root development. Periodic weighments of the above-ground portions of a whole row of plants combined with *in situ* root dissections have been found useful. These studies are timed to synchronize with important seasonal changes in growth conditions such as the beginning and end of summer, the periods of rains and winter. Indications are thus obtained of the manner in which the new canes pass through, and are influenced by, such seasonal changes as compared—and this is very important—with the local or standard canes in the plots. Particular attention is paid to the manner in which the new canes stand the critical periods for the sugarcane crop characteristic of the tract.

In selection work, bad or indifferent years have been found to be more useful than good years as canes which behave well in such years often possess a wide sphere of usefulness.

Juice analyses are done periodically during the cane crushing season—one at the beginning, one at the end and two or more in between. At each such analysis a whole row is cut and treated as the sample, rejecting only obvious immature shoots. These analyses include only for brix, sucrose content and purity; glucose determinations are limited to canes which are to be distributed outside Coimbatore for testing. Such analyses give data about the period of maturity of the canes—early, medium or late—their juice quality and the period during which the juices maintain their quality after ripening.

(d) *Distribution outside Coimbatore*

The Coimbatore Station consists of three bits of land containing five different soil types. Before distribution to outside stations the best of the selections are grown in more than one type of soil and their performance noted. When distributing canes for outside testing it is not only the very best that are sent out but quite a number of promising selections. This wider range is adopted to provide for certain seedlings performing better outside than at Coimbatore.

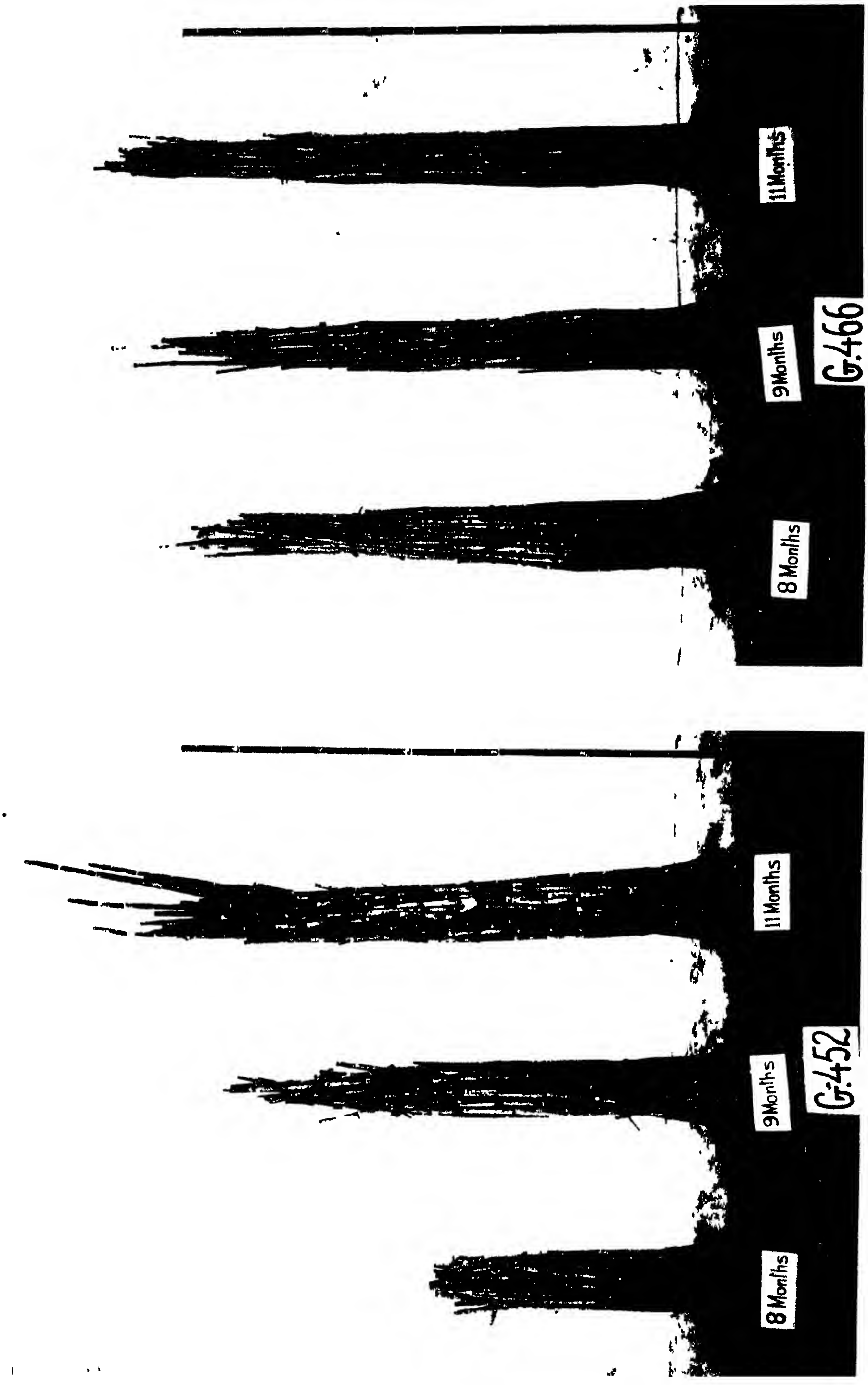
The Provincial Experiment Stations, of which there exists at least one in each province, test these canes under the local conditions and select for distribution such as are found the most suitable. In some tests the soil, manurial and other conditions are kept on a par with the prevalent conditions in the locality and not allowed to be better in any respect. This is considered essential for a correct estimate of the degree of superiority of the new canes over the standard varieties.

III. Salient features of the selection methods at Coimbatore

(a) *Wide range of parents*

The range of parents employed has been comparatively wide including at least five species of Saccharum, *viz.*, *Sacch. officinarum*, *Sacch. Barberi*, *Sacch. sinense*, *Sacch. spontaneum* and *Sacch. Narenga*. Coimbatore was the first to deliberately use *Sacch. spontaneum* as parent and, till recently, perhaps the only one which had successfully used *Sacch. Narenga* also. Coimbatore possesses a series of forms of *Sacch. spontaneum* whose range is perhaps wider than that available in most other sugarcane stations ranging from the dwarf Punjab form —hardly a foot high—to others which are perhaps more vigorous than *Sacch. robustum* *. This use of the wild Saccharums has been of particular use for North India, where the climatic and cultural conditions are far from favourable for

* A type of wild *Saccharum* collected in the island of New Guinea in 1928 by the Brandes-Jeswiet expedition and considered to possess remarkable vegetative vigour.



Stages in cane formation from the eighth to the twelfth month in two of the seedlings under test. (Harvest of a whole row).

canes of the ordinary type. Most of the now popular Coimbatore canes include in thier parentage some form of *Saccharum sponteneum* and also one of the indigenous Indian canes. In the year 1930 this range of parents was still further widened by the inter-generic cross with sorghum—the full possibilities of which have perhaps yet to be realized. All this has resulted in a comparatively wide range of characters in the seedlings obtained—a phenomenon dear to every cane-breeder.

(b) *Mass production of seedlings*

Quite a large number of seedlings are raised each season—sometimes to the tune of three to four hundreds of thousands—and this mass is rapidly filtered on comparatively easily noticeable vegetative and growth characters. This very large number, and the wide range of parents employed, have secured an extended range of variation in the seedlings population; and this has enabled selections to be made on the basis of large differences over the local or standard canes.

(c) *Rapid filtration of mass of new seedlings*

The filtration of seedlings at Coimbatore is comparatively rapid as the first stages of the process are based on easily noticeable vegetative characters. No attention is paid to seedlings which are seriously defective in any of the important characters; such are at once dropped from further studies and juice analyses. This appreciably curtails work and speeds up the filtering process.

(d) *Periodic studies*

The attempt is made to compare the new canes with the standards not merely at harvest but periodically; throughout their growth particular attention is paid to their ability to stand the critical periods and to take advantage of favourable periods for growth such as rainy weather. This enables selection to be made with some confidence. To quote one example Co. 285, which was selected as an improvement on Co. 205 for the Punjab as a result of such studies, has fully justified the method by its performance in the Punjab.

REFERENCES

Barber, C. A. (1916). *Mem. Dept. Agric. Ind., Bot. Ser.*, Vol. 8, No. 3, 103-199.

Venkatraman, T. S. (1925). *Agric. J. Ind.* **20**, 173.

Venkatraman, T. S. and Hussainy, Syed Abbas (1933). *Agric. and Live-Stock in Ind.* **3**, 1.

SUGGESTED METHOD OF JUICE ANALYSES FOR SUGARCANE PLANTATIONS DEVOID OF LABORATORY FACILITIES, PART II

BY

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I. Introduction

In a previous communication [Gopala Iyer and Venkatraman, 1934] it was shown that samples of sugarcanes from outlying stations, if packed in a particular manner, could be analysed at a central laboratory even after a five days' railway journey without introducing material errors in the juice analyses. The experiments described in that paper were mostly carried out on canes of the medium type and transported by rail to Coimbatore during the winter months of November-December.

Experiments on the windrowing of sugarcane during different parts of the year [Sanyal, 1925] have shown that, whereas in the cool winter months of North India windrowed canes remain in good condition for as long as fifty-one days, they soon show a tendency to deteriorate when windrowed during the hot summer months. Again, it is well-known that certain canes are more liable than others to deterioration of the juice, by inversion, during storage [Cross and Belile, 1914 and Haldane, 1933]. Experiments were, therefore, undertaken during the summer of 1934 to see if reliable juice analyses could be obtained at a central laboratory even on the thick type of canes after a railway journey during the hot months. The results are given in this paper.

II. Material and methods

One minor difficulty in the conduct of these experiments arose from the fact that most of the cane plots at the station are harvested before April-May, the right period for these tests. This difficulty incidentally led to the elucidation of certain precautions needed in handling canes well past the ripening stage.

Though carried out on three different occasions, the experiments divide themselves into two classes. The first class, which included the two varieties of

P. O. J. 2878 and Co. 349, contained canes from the main plots which were well past maturity and indeed had started rooting and shooting in the field. With the usual moisture in the packing material it was found that such canes rooted during transport; the condition of the canes, the prevailing summer heat and the moisture all apparently contributing to it.

Though rooting—and even a certain amount of shooting—is not of much consequence when the packing is for purposes of planting at the end of the journey, the rooting during transport was found to affect the juice. This led to the second class of experiments—with P. O. J. 2725, S. C. A. 410 * and *Poovan*—using more normal canes and curtailing the quantity of water used to moisten the packing material. In other respects the methods adopted were the same as those detailed in the previous paper. This stopped the rooting and the samples tallied better in their juice analyses.

III. Sampling and juice analyses

In dealing with P. O. J. 2878 and Co. 349 three-hundred-and-sixty canes were cut and divided into eighteen random samples of twenty canes each in the mill yard. Six samples were anlaysed on the day of cutting, six after three (or four) days' railway journey and the last six after seven (or eight) days' railway journey. The results are given in Tables I and II.

For P. O. J. 2725, S. C. A. 410 and *Poovan* (the local thick cane grown in the locality) 120 canes were cut of each variety and six pairs of sub-samples—each consisting of twenty canes—obtained by the method described in the previous paper. One member of each of the six pairs was analysed on the date of cutting and the other after a three days' railway journey. The results are given in Tables III, IV and V. The experiments were not continued beyond three days as there were indications that with the material available samples are not likely to keep beyond this period, which is ample in these days of fast train service.

IV. Discussion of results

As already mentioned there was some rooting in P. O. J. 2878 and Co. 349 after three days and a considerable amount after seven days. Even so, in the majority of cases the analyses do not show much change after a railway journey of three days. The rooting was found to be more profuse in the bottom than in the top halves, and separate analyses of the two halves showed that the change in juice quality was greater in the bottom halves [Tables VI (*a*), VI (*b*), and VI (*c*)]. After seven days the deterioration was very great.

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* This is a hybrid between P. O. J. 2725 and *Sorghum Durra* stapf. The lettering is that used strictly within the station. Seedlings distributed outside for trial are always denoted by 'Co' numbers.

Of the other varieties, P. O. J. 2725 showed some rooting after three days, particularly in samples C and D, and this is reflected in the analyses. In the other samples there is not much change after three days, the difference being statistically insignificant when C and D are omitted.

In the varieties S. C. A. 410 and *Poovan* there is very little change after a three days' journey. Statistically examined by Fisher's '*t*' test, the differences were found to be not significant, being even less than the standard error in most cases.

V. Conclusions

Samples of the thick or 'noble' type of sugarcanes –if packed in the manner referred to—can be analysed after a three days' railway journey to a central laboratory without introducing any material error into the analyses.

The water used for moistening the packing material should be considerably curtailed when cane parcels are transported by rail during the hot summer months. Moisture should be cut down to such an extent as to inhibit rooting of the canes during transport. Canes well past the ripening stage are particularly prone to rooting. Such rooting during transport affects the juice quality.

REFERENCES

Cross William, E. and Belile, J. L. (1914). *Inter. Sugar Jour*. **17**, 218.

Gopala Ayyar, K. V. and Venkatraman, T. S. (1934). *Agric. and Live Stock in Ind.* **4**, 371.

Haldane John, H. (1933). *Inter. Sugar Jour*. **35**, 140-143.

Sanyal, P. B. (1925). *Mem. Dept. Agri. Ind., Chem. Ser.*, Vol. VIII, No. 7, December **1925**.

TABLE I

Juice analyses of P. O. J. 2878 after varying periods of railway journey

	Brix percentage			Sucrose percentage			Glucose percentage			Co-efficient of purity		
	On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days	
		4	8		4	8		4	8		4	8
	20·98	21·36	20·18	18·66	19·00	17·30	0·368	0·450	0·805	89 0	88·9	85·7
	20·78	21·15	20·57	18·65	18·92	17·95	0·374	0·409	Not done	89·7	89·5	87·3
	20·25	20·20	20·51	17·83	17·41	17·80	0·422	0·747	0·731	88·1	86·2	86·8
	20·73	19·75	20 36	18·32	16·71	17·59	0·398	0·720	Not done	88·4	84·6	86·4
	20·88	20·27	20 29	18·61	17·80	17 42	0·325	0·546	0·869	89·1	87·8	85·9
	19·52	20·54	19·70	16·84	18·25	16 82	0·684	0·475	Not done	86·3	88·9	85·4
Mean	20·52	20·55	20·27	18·15	18·02	17·48	0·429	0·558	0·802	88·4	87·7	86·3

TABLE II

Juice analyses of Co. 349 after varying periods of railway journey

	Brix percentage			Sucrose percentage			Glucose percentage			Co-efficient of purity		
	On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days	
		3	7		3	7		3	7		3	7
	21·01	21·37	20·76	18·73	19·04	18·05	0·326	0·317	0·734	89·1	89·1	86·9
	22·19	20·87	20·63	20·10	18·37	17·95	0·206	0·500	0·694	90·6	88·0	87·0
	21·60	21·17	20·85	19·44	18·87	18·31	0·267	0·392	0·574	90·0	89·1	87·8
	21·93	21·73	20·80	19·74	19·42	18·03	0·246	0·362	0·686	90·1	89·4	86·7
	20·29	21·15	20·02	18·02	18·74	17·95	0·459	0·471	0·656	88·8	88·6	87·6
	20·89	20·69	20·72	18·85	18·37	18·29	0·484	0·435	0·633	90·2	88·8	88·3
Mean	21·32	21·16	20·63	19·15	18·80	18·10	0·331	0·413	0·663	89·8	88·8	87·4

TABLE III

Juice analyses of P. O. J. 2725 after 3 days' railway journey

Sample	Brix percentage		Sucrose percentage		Glucose percentage		Co-efficient of purity		Remarks
	On date of cutting	After 3 days	On date of cutting	After 3 days	On date of cutting	After 3 days	On date of cutting	After 3 days	
A	20·64	20·77	18·23	18·41	0·408	0·380	88·3	88·6	Mean difference in brix between 3 days' sample and fresh . . . —0·21 Standard error of difference 0·180 Critical difference (P = 0·05) 0·462
B	20·49	20·07	18·39	17·67	0·440	0·528	89·8	88·0	Mean difference in sucrose between 3 days' sample and fresh . . —0·46 Standard error of difference 0·241 Critical difference (P = 0·05) 0·620
C	20·24	19·77	18·03	17·11	0·443	0·652	89·1	86·5	Mean difference in glucose between 3 days' sample and fresh . . . 0·084
D	20·09	19·27	17·82	16·61	0·362	0·617	88·7	86·2	Standard error of difference 0·051 Critical difference (P = 0·05) 0·131 Mean difference in purtiy between 3 days' sample and fresh . . —1·4
E	20·44	20·37	18·30	18·02	0·320	0·347	89·6	88·5	Standard error of difference 0·469 Critical difference (P = 0·05) 1·21 Omitting C & D mean difference in purity . —0·8
F	20·19	20·57	18·11	18·33	0·386	0·340	89·7	89·1	Critical difference (P=0·05) 1·14
Mean .	20·35	20·14	18·15	17·69	0·393	0·477	89·2	87·8	

TABLE IV

Juice analyses of S. C. A. 410 after 3 days' railway journey

Sample	Brix percentage		Sucrose percentage		Glucose percentage		Co-efficient of purity		Remarks
	On date of cutting	After 3 days	On date of cutting	After 3 days	On date of cutting	After 3 days	On date of cutting	After 3 days	
A	20·09	19·97	17·86	17·86	0·208	0·229	88·9	89·4	Mean difference in brix between 3 days' sample and fresh . . . —0·08
B	20·69	20·87	18·53	18·71	0·222	0·196	89·6	89·6	Standard error of difference 0·15 Critical difference (P=0·05) 0·394
C	20·45	20·37	18·38	18·29	0·194	0·229	89·9	89·8	Mean difference in sucrose between 3 days' sample and fresh . . . —0·02 Standard error of difference 0·161
D	21·05	20·32	19·04	18·31	0·139	0·240	90·5	90·2	Critical difference(P=0·05) 0·413 Mean difference in glucose between 3 days' sample and fresh . . . 0·017
E	21·92	22·30	19·71	20·25	0·128	0·121	89·9	90·8	Standard error of difference 0·019 Critical difference (P=0·05) 0·049 Mean difference in purity between 3 days' sample and fresh . . . 0·20
F	21·15	21·03	19·02	19·03	0·199	0·180	89·9	90·4	Standard error of difference 0·187 Critical difference (P=0·05) 0·481
Mean .	20·89	20·81	18·76	18·74	0·182	0·199	89·8	90·0	

TABLE V

Juice analyses of Poovan after 3 days, railway journey

Sample	Brix percentage		Sucrose percentage		Glucose percentage		Co-efficient of purity		Remarks
	On date of cutting	After 3 days	On date of cutting	After 3 days	On date of cutting	After 3 days.	On date of cutting	After 3 days	
A	17·05	16·88	14·31	14·02	1·43	1·58	84·0	83·1	Mean difference in brix between 3 days' sample and fresh . . . . . —0·01 Standard error of difference 0·142 Critical difference (P=0·05) 0·364 Mean difference in sucrose between 3 days' sample and fresh . . . —0·07 Standard error of difference 0·176 Critical difference (P=0·05) 0·452 Mean difference in glucose between 3 days' sample and fresh . . . 0·07 Standard error of difference 0·049 Critical difference (P=0·05) 0·127 Mean difference in purity between 3 days' sample and fresh . . . —0·4 Standard error of difference 0·48 Critical difference (P=0·05) 1·24
B	17·61	17·39	14·97	14·55	1·42	1·63	85·0	83·5	
C	17·75	17·79	15·32	15·36	1·40	1·42	86·3	86·3	
D	17·26	17·69	14·66	15·31	1·43	1·30	85·0	86·6	
E	17·51	17·84	14·95	15·24	1·43	1·46	85·4	85·4	
F	17·46	16·98	14·81	14·16	1·49	1·61	84·9	83·4	
Mean	17·44	17·43	14·84	14·77	1·43	1·50	85·1	84·7	

TABLE VI (a)

Juice analyses of P. O. J. 2878 'tops' after varying periods of railway journey

Brix percentage			Sucrose percentage			Glucose percentage			Co-efficient of purity		
On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days	
	4	8		4	8		4	8		4	8
19·99	20·41	19·30	17·39	17·83	16·26	0·631	0·614	1·029	87·0	87·4	84·2
19·98	20·37	19·31	17·59	17·89	16·57	0·651	0·650	Not done	88·0	87·8	85·8
18·99	19·67	19 61	16·24	16·93	16·77	0·728	0·847	0·987	85 5	86·1	85·5
19·98	18·82	19·01	17·39	15·59	15·99	0·660	0·857	Not done	87·0	82·8	84·1
20·32	19·42	19·31	17·81	16·70	16·34	0·507	0·783	0·902	87·6	86·0	84·6
17·87	18·97	18·11	14·57	16·47	15·06	1·150	0·728	Not done	81·6	86·8	83·2
19·52	19·61	19·11	16·83	16·90	16·17	0·721	0·747	0·973	86·1	86·2	84·6

TABLE VI (*b*)

Juice analyses of P. O. J. 2878 'bottoms' after varying periods of railway journey

Brix percentage			Sucrose percentage			Glucose percentage			Co-efficient of purity		
On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days		On date of cutting	After railway journey in days	
	4	8		4	8		4	8		4	8
22·00	22·24	21·05	19·98	20·07	18 34	0·097	0·301	0·581	90·8	90·2	87·1
21·56	21·84	21·88	19·68	19·92	19·40	0·105	0·182	Not done	91·3	91·2	88·7
21·52	20·74	21·44	19·44	17·89	18·90	0·112	0·645	0·463	90·4	86·3	88·2
21·50	20·67	21·64	19·29	17·82	19·11	0·126	0·582	Not done	89 7	86·2	88·3
21·45	21·14	21·33	19·39	18·91	18·57	0·146	0·304	0·834	90·4	89·5	87·1
21·17	22·10	21·21	19 08	20·03	18·51	0·222	0·221	Not done	90·1	90 6	87·3
21·53	21·46	21·43	19·48	19·11	18·81	0·135	0·373	0·626	90·5	89·0	87·8

TABLE VI (c)

Statistical examination of the juice analyses results of P. O. J. 2878 'tops' and 'bottoms' after varying periods of railway journey

—	Brix percentage		Sucrose percentage		Glucose percentage		Co-efficient of purity	
	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Mean difference between sample after 4 days and on the date of cutting .	0·09	—0·07	0·07	—0·37	0·026	0·238	0·1	—1·5
Standard error of difference	0·468	0·304	0·615	0·451	0·101	0·0812	1·21	0·92
Critical difference (P=0·05)	1·043	0·677	1 367	1·006	0·226	0·181	2·70	2·04
Mean difference between sample after 8 days and on the date of cutting .	—0 41	—0·10	—0 66	—0·67	0·252	0·491	—1·5	—2·7
Standard error of difference	0·435	0·167	0·560	0·209	0·1335	0·076	1·06	0·36
Critical difference (P=0·05)	0·968	0·373	1·247	0·466	0·315	0·179	2·37	0·80

HYDROGEN-ION CONCENTRATION AND THE PRESERVATION OF MANGOES

BY

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In the course of experiments [Banerjee *et al.*, 1934] on the storage of mangoes, it was observed that, so long as the acidity of the fruit was high, decay would not set in. But as ripening progressed and acidity went down, black or grey patches of rotting appeared and the fruit gradually perished. A number of mature mangoes were therefore allowed to ripen at room temperature and some of them were smeared on the skin with rotten pulp from decaying mangoes. This enabled one to determine the resistance of the skin as also to find whether a rotting mango needs isolation from other fruits. It was observed that they ripen as usual with other mangoes, except for the film of pulp on the skin, which exerts a mild retarding effect on respiration. On keeping longer they develop patches of rot just as other mangoes did. In a well ventilated room, if the skin of the fruit is kept dry, there is little risk of fungal decay setting in. The same observation has been noticed by other workers on fruits and vegetables, who find little difficulty in preserving acid food products but experience spoilage in low acid products even with a high quantity of preservative (sodium benzoate over 0·1 per cent) [Cruess, 1932]. The toxicity of several preservatives depends on the H-ion concentration of the medium. In a tropical country like India, where spoilage due to infection is a serious consideration, the minimum of antiseptic can be used successfully only when the H-ion concentration of the product is properly adjusted. This is necessary because the use of antiseptics is generally discouraged. Experiments were therefore carried out to find out the preservative action of antiseptics on mango juice at different H-ion concentration.

Fully-ripe mango pulp was boiled with water, and the filtered juice was used as the medium for testing the growth of micro-organisms. Citric acid and ammonia were used to adjust the pH value. Sodium salicylate, sodium benzoate, sodium sulphite, boric acid, formalin and sulphur dioxide were the antiseptics

tried. *Mycoderma*, wild yeast, *Aspergillus niger*, *Penicillium glaucum* two types) and *B. Coli* and one type of *Penicillium glaucum* that was isolated from a rotting citrus fruit were obtained by culture from rotting mango. To 10 c.c. of mango juice adjusted to pH 2, 3, 4, 5, and 6 were added the antiseptic in concentrated solutions to obtain different dilutions of the same. These tubes were then innoculated with a drop of the living culture, and the time in days for the micro-organisms to grow was noted. A clear solution even after 10 days was taken, as toxic for the culture. The results are given in tables that are appended.

It will be seen from the tables that sodium sulphite and boric acid are not much good in preserving mangoes unless a very large quantity of the antiseptic is used. Sodium salicylate and benzoate are almost equal in antiseptic action at pH 2 to pH 3 ; pH 4 is the limiting acidity beyond which a higher quantity of the antiseptic is necessary. Formalin is not very striking in its antiseptic action. Sulphur dioxide gives the best results of the antiseptics tried both as regards acidity and antiseptic action. For practical purposes, 0·05 to 0·1 per cent of the antiseptic works satisfactorily. It is more effective than other antiseptics at lower H-ion. Upto pH 4, 0·05 per cent of the antiseptic is useful and for lower hydrogen-ion, 0·1 per cent is necessary ; 0·08 per cent of the antiseptic is then an average all-round figure for general use.

These results were verified on a practical scale, by storing ripe mangoes peeled and sliced in wide-mouthed glass bottles, and filling them with syrup containing antiseptic at different H-ion. The H-ion of ripe mango fruits varies from 4·5 to 5·5. The H-ion of the fruits was adjusted to 2·5, 4, and that of the fruit as such, which on an average will be 5. Sodium salicylate, sodium benzoate and sulphur dioxide were the antiseptics added to 0·1 per cent strength. The bottles were first stored in the cold room at zero degree centigrade to stop all enzymatic action. After being stored in the cold for a fortnight to one month, half the bottles were taken out and left at room temperature (20°—30°C.). The bottles were examined from time to time till stored for nearly two years. For 6 months all the bottles keep well, but later the sodium benzoate and sodium salicylate bottle pulps slowly lose the freshness in taste. Wide variations in temperature during storage cause the pulp to lose its texture. Bottles stored at room temperature suffer from this defect. Higher the acidity, the better the taste. Presence of air in the bottle neck space decolorises the pulp near the top. Sulphur dioxide-preserved bottles suffer little from this defect. In the cold room, sulphur dioxide bottles keep quite well for nearly two years, only the pulp loses slightly in firmness. By this method mango can be stored satisfactorily without sterilisation or canning. However, this method requires a cold treatment for the pulp to stop enzymatic change. The quantity of the antiseptic used is permitted by the food laws of America. The vitamins are also preserved.

Summary

Mango pulp can be stored satisfactorily at a pH between 2·5 to 5 after a cold storage to stop enzymatic activity. Addition of citric or tartaric acid to raise the acidity helps in storage, as also the taste of the preserved product. Sulphur dioxide is the best antiseptic to use, as it preserves best the colour and texture of the pulp.

REFERENCES

Banerjee, B. N., Karmarkar, D. V. and Row, G. R. (1934). *Agric. and Live-stock in India*, **4**, **86**.

Cruess, W. V. (1932). *Ind. & Eng. Chem.*, Vol. 24, No. 6.

TABLE I

Antiseptic	MICRO-ORGANISM																													
	B. Coli					Wild yeast					*Mycoderma*					*P. glaucum* (citric)					*P. glaucum* (mango)					*Asp. niger*				
	PH																													
	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
Sodium sulphite— Per cent																														
1	...	...	2	2	2	5	5	2	2	2	...	8	5	5	5	...	...	2	2	2	...	...	5	2	2	...	8	2	2	2
0·5	2	...	2	2	2	...	4	2	2	2	8	8	2	1	1	5	...	2	2	2	...	...	5	2	2	...	...	2	2	2
0·2	2	2	2	2	2	2	2	2	2	2	5	2	1	1	1	2	5	2	2	2	5	...	5	2	2	8	2	2	2	2
0·05	2	2	2	2	2	2	2	2	2	2	5	1	1	1	1	2	2	2	2	2	2	5	2	2	2	2	2	2	2	2
Boric acid— Per cent																														
0·5	9	2	2	2	2	...	...	...	...	...	...	...	...	...	...	...	2	2	2	2	...	2	2	2	2	6	2	2	2	2
0·2	9	2	2	2	2	...	...	3	3	3	...	...	6	...	...	2	2	2	2	2	...	2	2	2	2	4	2	2	2	2
0·05	9	2	2	2	2	...	3	3	3	3	...	2	2	2	2	2	2	2	2	2	...	2	2	2	2	2	2	2	2	2
Sodium salicylate— Per cent																														
1	...	...	...	2	2	...	...	...	4	2	...	...	...	...	..	..	...	...	5	5	...	...	...	8	2	...	...	...	3	2
0·5	...	...	...	2	2	...	...	...	4	2	...	...	...	...	.	..	...	...	5	2	...	...	...	5	2	...	...	...	2	2
0·2	...	...	...	2	2	...	...	...	2	2	...	...	...	...	1	...	..	8	2	2	...	...	...	2	2	...	...	8	2	2
0·05	...	...	2	2	2	...	...	2	2	2	...	...	1	1	1	...	...	2	2	2	...	...	2	2	2	...	8	2	2	2
Sodium benzoate— Per cent																														
1	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	...	...	...	...	...	...	...	...	...	3
0·5	...	...	...	2	2	...	...	...	...	2	...	...	...	...	...	...	...	...	11	5	...	...	...	...	5	...	...	...	...	2
0·2	...	...	2	2	2	...	...	...	2	2	...	...	...	1	1	...	...	5	5	2	...	...	...	5	2	...	...	...	2	2
0·05	...	2	2	2	2	...	4	2	2	2	...	...	1	1	1	...	...	5	2	2	...	...	5	2	2	...	...	2	2	2

Sulphur dioxide— Per cent																															
0·5 . .	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0·2 . .	...	...	...	...	...		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0·05 . .	...	...	...	...	5		...	...	...	...	...	...	...	...	...	10	...	...	...	...	...	...	...	9	8	3	...	...	...	...	...
0·02 . .	...	7	5	5	5		...	5	3	3	2	...	...	10	3	3	...	...	...	9	9	...	3	3	2	2	...	...	...	9	7
Formalin— Per cent						Per cent																									
1 . .	...	...	...	.	..	1	...	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
0·2 . .	..	...	...	2	2	·5	5	3	2	2	2	...	...	...	...	...	...	...	...	8	5	5	5	5	5	2	...		...	...	...
0·05 . .	2	2	2	2	2	·2	2	2	2	2	2	...	...	...	...	...	6	5	2	2	2	5	2	2	2	2	...	...	...	...	...
0·02 . .	2	2	2	2	2	·05	2	2	2	2	2	...	...	...	...	...	2	2	2	2	2	5	2	2	2	2	...	...	...	...	...

A STUDY OF THE VIABILITY OF SOME COMMON WINTER VEGETABLE SEEDS.

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Introduction

A good stand of a crop which primarily depends on the viability of seed is the first essential thing in successful crop-growing. Information relating to the factors which influence the germinating capacity of seeds is, therefore, of practical importance for the grower. Useful work on the effect of age on the germination capacity of common field crops has been done at Poona by Sonavne [1928, 1934].

In this paper are described the results of experiments conducted during the last four years at Lyallpur to find out the effect of (1) age and (2) the method of storing on the germinating capacity of some important winter vegetable seeds. A study of this nature with vegetable seeds is all the more important because they are more costly to buy and difficult to produce. It is believed that the information contained in this article will be of practical importance to the cultivators, because vegetable growing is increasing in importance on account of low prices of ordinary field crops.

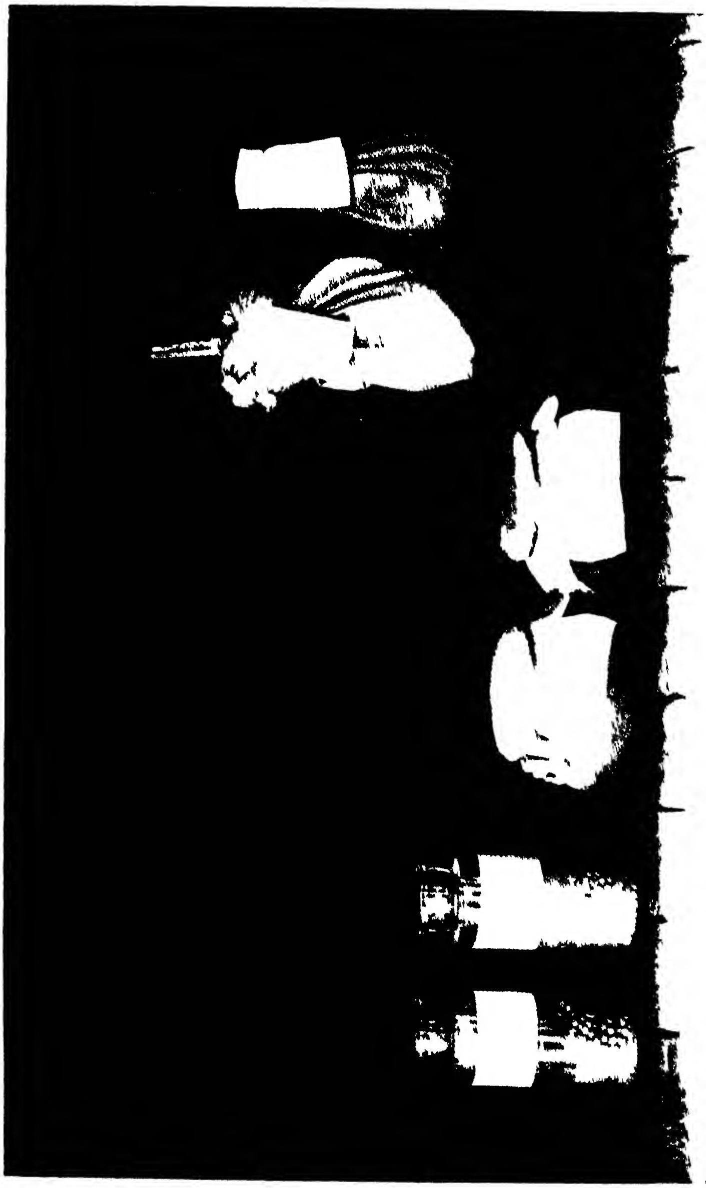
Procedure

The seeds of (1) cauliflower (*Brassica oleracea*), (2) red turnips (*Brassica Rapa*), (3) *deshi* radish (*Raphanus sativus*), (4) onions (*Allium Cepa*), (5) peas (*Pisum sativum*) and (6) *methi* (*Trigonella Foenum-graecum*) were stored by three different methods commonly followed in the country, with and without naphthalene, in April and May 1931, in the manner described below. The seeds were produced at the College Farm, Lyallpur. Seed of each crop was divided into six lots and stored as given below :—

(1) In glass bottles with naphthalene.

(2) In glass bottles without naphthalene.

(3) In earthen containers (called *kujjas*) with naphthalene.



Methods of storing of seeds followed in the experiment

(4) In earthen containers (called *kujjas*) without napthalene.
(5) In cloth bags with napthalene.
(6) In cloth bags without napthalene.

Glass bottles were corked. The mouths of the earthen containers were covered with earthen covers and tied with cloth. The mouths of cloth bags were closed by means of strings. The photographs of the containers are given in plate XLVII.

The containers were placed on a shelf in the go-down side by side so that all of them may remain under similar conditions with regard to air, temperature and atmospheric humidity.

Germination tests were made each year during September and October, which is the usual time for sowing these crops. From a practical point of view there is no use of testing germination at other times of the year because a cultivator sows these seeds only during the usual sowing season. Germination tests were conducted in Dr. Dreyer's Seed Germinating Apparatus*, which is also popularly called germinating dish. Measured quantity of clean sand was added to each dish. One hundred depressions were made in sand in each dish by means of the moulding disc. One seed was put in each depression, thus there being one hundred seeds in each dish. A measured quantity of sand was again used to cover the seeds. Sand was then moistened with a measured quantity of water, which was previously determined to make sand sufficiently moist. It would be seen that the quantities of sand and water were the same in each dish. The dishes were then covered with glass plates and glass covers. Observations were started next day after sowing and were continued for 14 days; germinations were recorded daily and the germinated seeds removed from the dish. Before throwing them away these were counted again to check the figures recorded in the first instance.

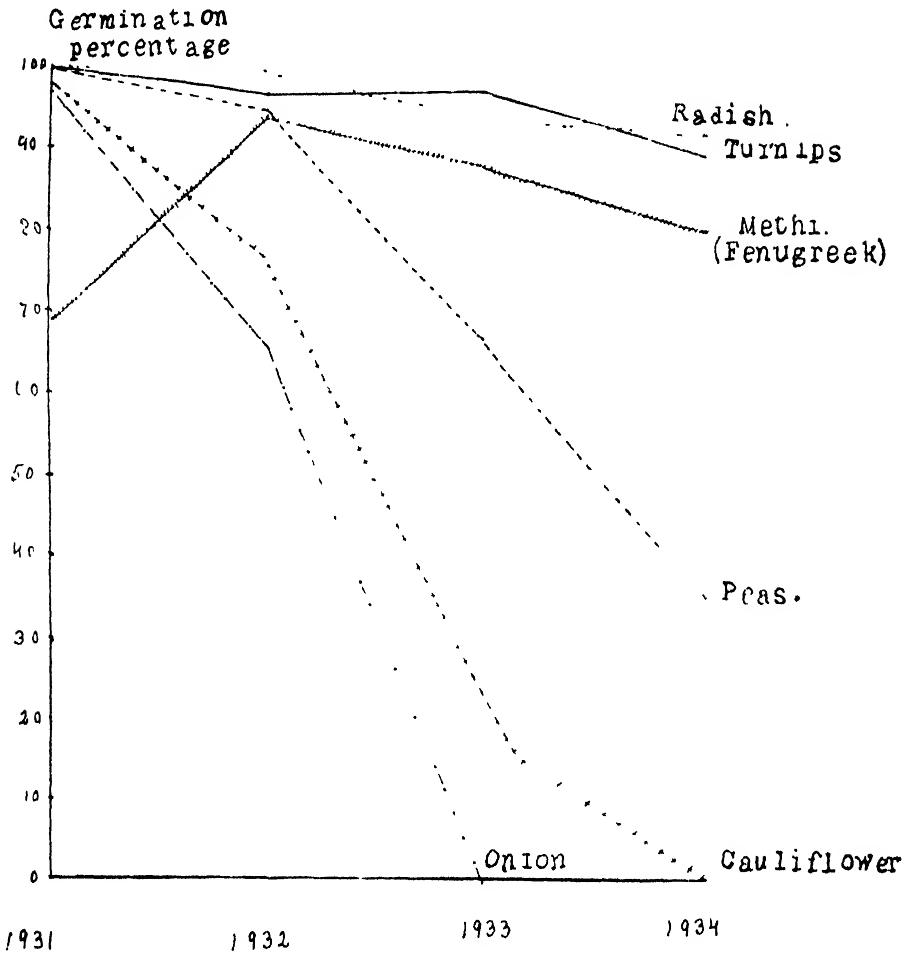
It has already been stated that seeds were stored in six different ways. One hundred seeds were taken from each container. Six hundred seeds of each crop were thus tested for germination every year. In order to take a representative sample from each container all the seed that it contained was taken out and well mixed on a sheet of paper. It was then divided into few lots approximately equal in size. Twenty-five seeds were then taken from each lot indiscriminately, thus making one hundred seeds from each container and six hundred for each crop.

Moulds appeared in a few cases in the first year. No observations were recorded from mouldy dishes. They were rejected and fresh tests made after sterilizing the dishes and the sand. After this treatment no moulds appeared in the subsequent year.

The results obtained are given in Tables I and II. In the graph and Table I the figures of germination percentage of seeds stored in bottles with napthalene

*Dr. Dreyer's Seed Germinating Apparatus consists of a glass dish 175 m.m. diameter with slotted edge and with a glass plate with slots to correspond with the slots in a dish and a glass cover and a moulding disc.

are given separately, so that a relative idea of the longevity of the seeds under experiment may be seen at a glance.



Comparative germination percentage of some winter vegetable seeds.

Table II contains the figures of germination for all the methods of storage used in this experiment. The relative merits of the various methods can be seen from this table.

Discussion of the results

From Table I it would be observed that all seeds with the exception of *methi* (*Trigonella Foenum-graecum*) germinated almost cent per cent, in the first

year. The life of onion (*Allium Cepa*) and cauliflower (*Brassica oleracea*) seeds is shorter than that of other seeds. Onion (*Allium Cepa*) seed lost its germinating power completely after two seasons. Cauliflower (*Brassica oleracea*) comes next. In the third season its germination capacity was only 16 per cent. *Radish (*Raphanus sativus*) and *turnips (*Brassica Rapa*) seeds seem to retain their viability very well. Their germination percentage is about 90 per cent even in the fourth season.

The germination percentage of *methi* (*Trigonella Foenum-graecum*) was only 69 in the first season. In the second season it rose to 94. In the fourth season it was 80 per cent. This strange behaviour of the crop is due to the presence of hard seeds whose germination capacity improved with age. The fact that low percentage of germination of *methi* (*Trigonella Foenum-graecum*) in the first season was due to the presence of hard seeds was definitely established by actual experiments. It was found that the seed of *methi* (*Trigonella Foenum-graecum*) in the first season contained on an average 28 per cent of hard seeds, while in the fourth season the percentage of hard seeds fell as low as five. The presence of hard seeds was determined by the following methods:—The seeds were soaked in water for ten hours after which period it was found that some seeds did not swell. They settled at the bottom while soft seeds absorbed moisture and increased in size. The soaked seeds (hard as well as soft) were then kept in one per cent osmic acid for four hours. All the swollen seeds

TABLE I

Showing the germination of vegetable seeds each year

Serial No.	Common name	Botanical name	Germination percentage			
			1931	1932	1933	1934
1	Cauliflower . .	*Brassica oleracea* . .	98	77	16	0
2	Onion . .	*Allium Cepa*	97	66	0	0
3	Turnips . .	*Brassica Rapa* . . .	100	97	97	89
4	Radish . .	*Raphanus sativus* . .	100	100	95	91
5	*Methi* (Fenugreek)	*Trigonella Foenum graecum*	69	94	88	80
6	Peas . . .	*Pisum sativum* . .	100	96	67	35

N. B.—This is well illustrated by the graph given on the previous page.

* Radish and turnips seeds were of the local varieties.

Table II

Showing the germination percentage of vegetable seeds in different methods of storing seeds with or without napthalene balls

Serial No.	Common name	Botanical name	Year	Germination percentage: Bottle, With napthalene	Bottle, Without napthalene	*Kuffas*, With napthalene	*Kuffas*, Without napthalene	Cloth bag, With napthalene	Cloth bag, Without napthalene
1	Cauliflower .	*Brassica oleracea* .	1931	98	99	97	97	99	97
			1932	77	78	78	76	67	67
			1933	16	13	14	15	6	4
			1934	0	0	0	0	0	0
2	Turnips . .	*Brassica Rapa* .	1931	100	100	99	100	100	100
			1932	97	97	97	96	85	88
			1933	97	97	95	96	77	77
			1934	89	88	90	87	69	67
3	Radish . .	*Raphanus sativus* .	1931	100	100	100	100	100	100
			1932	100	99	100	100	90	91
			1933	95	93	96	93	85	85
			1934	91	88	90	90	73	72
4	Onion . .	*Allium Cepa* . .	1931	97	96	98	97	96	97
			1932	96	67	67	65	64	63
			1933	0	0	0	0	0	0
			1934	0	0	0	0	0	0
5	*Methi* (Fenugreek).	*Trigonella Foenum-graecum.*	1931	69	71	71	68	70	69
			1932	94	93	94	91	92	92
			1933	88	88	87	85	79	81
			1934	80	81	81	79	76	75
6	Peas . .	*Pisum sativum* .	1931	100	100	100	98	100	100
			1932	96	77	94	70	67	41
			1933	67	21	67	12	23	14
			1934	35	3	33	4	12	2

became black in colour while the seeds that had settled at the bottom and had not swollen did not change in colour and were as hard as before The sections of hard seeds were cut with microtome and were examined under microscope. A continuous layer of malpighian cells was seen in the seed-coat of the seed. In the case of soft seeds the layer of malpighian cells was found cracked near the hilum.

The germination of peas (*Pisum sativum*) in the third season was about two third of what it was in the first year. In the fourth year it was only 35 per cent.

The effect on germination of the different methods of storage and of the presence and absence of napthalene would be seen from Table II. Earthen containers and bottles were equally effective in this respect. In cloth bags seeds retained their germination capacity up to the first season which comes about four months after the harvest. But they deteriorated when kept longer.

The earthen containers have got small pores. Some practical vegetable-growers believe that they are better for storing seeds than bottles. They believe

that dry fresh air is essential for the health of seeds which reaches them through the porous walls of earthen containers, moisture vapours contained in it being absorbed by the walls. These results, however, show that earthen containers have no advantage over glass bottles which are not porous. Only the cost should, therefore, determine whether one should use earthen containers, glass bottles or tin boxes.

Napthalene does not appear to have impaired germination power of the vegetable seeds. There was no damage by insects to any seed excepting peas, even in the absence of napthalene. In the case of peas, the seed stored without napthalene was damaged badly by insects by the second season. Peas seed stored with napthalene was free from damage in all the methods of storage tried in this experiment. Germination of peas seeds stored without napthalene is low in all cases. This is due to the seeds having been damaged by insects.

These observations definitely show that the germination power of the vegetable seeds is not in any way impaired by storing them with napthalene balls, and the presence of napthalene is, rather, advantageous because it keeps the vegetable seeds (such as peas) safe from the attack of insects. It is, therefore, advisable to make the addition of napthalene balls to the vetegable seeds stored for future use in order to keep them free from insect attack.

Conclusions

(1) Seeds of some vegetable crops retain their vitality for a longer period than others. For example, the germination of cauliflower (*Brassica oleracea*) seeds is only 16 per cent after two seasons. Seeds of turnips (*Brassica Rapa*), radish (*Raphanus sativus*) and *methi* (*Trigonella Foenum-graecum*) give germination percentage above 80 even in the fourth season.

(2) *Methi* (*Trigonella Foenum-graecum*) seeds improved during storage and gave maximum germination in the second season.

(3) The vegetable seeds can be stored in bottles and earthen containers equally well but in cloth bags they lose their power of germination after the first season.

(4) Napthalene does not impair the germination of seeds. It should be kept in seeds in order to be absolutely certain of freedom from insect attack.

(5) A vegetable-grower should test the germination capacity of seeds if he has to buy them from outside, especially in the case of crops whose seeds deteriorate rapidly with age, such as onions and cauliflowers.

References

Sonavne, K. M. (1928). *Agric. J. Ind.* **23**, 271.

————————(1934). *Agric. & Live-stock in Ind.* **4**, 287.

THE DAMAGE TO CROPS IN THE NASIK DISTRICT BY THE FROST OF JANUARY 1934

BY

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The Nasik District was in the grip of severe cold spells in January 1934, the preceding cold spell having occurred in 1929. In this article, it is proposed only to record the event with its catastrophic consequences on crops in this district.

The present occurrence was of a peculiar nature. In 1929, the cold wave occurred only once between the 27th of January and 3rd February, whereas this year there were three distinct cold spells between the 10th and 31st of January. The first of these occurred on the night of the 12th, the second on the night of the 19th and the third on the night of the 29th. The occurrence of the cold spells three times within the short space of three weeks intensified the damaging effects on vegetation, so that the portions of crops that were saved in the first suffered in the second or the third. Ice formed in open reservoirs, notably at Nasik, Ozar-Tambat and Kalvan in the Nasik District.

TEMPERATURES

The data of temperatures in shade recorded by intelligent grape-gardeners, at the places mentioned, during the period of the cold spell are given below :—

Dates	At Nasik	At Ozar-Tambat	Remarks
January 1934	Degrees in F.	Degrees in F.	
11th	44	44	
12th	44	45	
13th	29	31	Frost
14th	32	32	

Dates	At Nasik	At Ozar-Tambat	Remarks
January 1934	Degrees in F.	Degrees in F.	
15th	41	40	
16th	42	42	
17th	46	46	
18th	48	40	
19th	49	37	
20th	32	34	Frost
21st	33	36	
22nd	39	33	
23rd	40	42	
24th	42	43	
25th	45	45	
26th	48	50	
27th	48	51	
28th	51	51	
29th	45	50	
30th	31	34	Frost
31st	33	36	

The temperatures recorded in the open fields where crops were growing may be expected to have been still lower and the experiences at one or two places showed that the temperatures in field were lower than those in shade by 6°F. to 7°F. The temperatures thus fell 15°F. to 20°F. below normal over a large part of the affected area.

Tracts affected

The damage due to frost, though serious, was patchy and showed complete ruin in one village and absolute escape in the adjoining one. The dividing line

between the affected and non-affected zones could be drawn from Taharabad in the extreme north-west corner passing through Satana, Deola, Vadner, Kundewadi, Sukene, Adgaon, Nasik and Trimbak. In the tract to the west of this line lay the affected zone, that to the east being the non-affected one.

FIG. 1.—Map of the Nasik District showing the affected and non affected zones

Note.—Dotted lines show the dividing line

CROPS AFFECTED

The green appearance of the crops and vegetation, in general, changed all of a sudden into a dry and burnt one. The tops, leaves, grain and fruits presented a dried-up and ghastly aspect. The grain in most cases turned black with shrivelled and spotted appearance. The succulent leafy growth, shoots and stems turned brown and stiff. Even some road-side trees were dried up and defoliated.

Among the cultivated crops, it was observed that bananas were the first to suffer; they began to undergo a process of drying-up at the shade temperature of 41°F. Tomatoes, brinjals, chillies and gourds were the next to suffer. From

DAMAGE TO CROPS BY FROST

FIG. 1.—Guava plantations that were affected

FIG. 2.—Affected sugarcane crop

Serial No.	Wire received on	Contents of wire	Actual experience in Nasik area	Remarks
7	13th January 1934 . .	Below 35°F. .	28-29 F. .	Frost occurred
8	15th January 1934 . .	Below 40 F. .	41°F	
9	18th January 1934 .	Below 45°F. .	48°F.	
10	20th January 1934 . .	Below 45°F. .	30-32°F. .	Frost occurred
11	21st January 1934 . .	Below 35°F. .	32-33°F.	
12	22nd January 1934 . .	Below 40°F. .	39°F.	
13	23rd January 1934 . .	Below 40 F. .	40°F.	
14	30th January 1934 .	Below 45 F. .	30-31°F. .	Frost occurred
15	31st January 1934 . .	Below 35°F. .	31-33 F.	
16	2nd February 1934 . . .	45 F . .	44°F.	

Temperatures from 41°F to 45°F. were found to be not causing any damage to crops and, therefore, to be more precise in future, arrangements are being made to receive wires only when the temperature is likely to fall below 40°F.

An elaborate net work organisation is also under contemplation with a view to give a speedy and effective circulation to the news among the gardeners.

(*b*) *Heating in the gardens.*—In foreign countries, notably in America, oil-heaters are used for adding heat artificially to keep up the required temperatures in gardens on such occasions. The practice prevalent here, however, consists in keeping ready heaps of wooden loppings mixed with dried cowdung all through the garden at a distance of 8 to 10 feet and lighting them up after midnight so as to generate smoky fires, thereby enveloping the garden with dense smoke. This has not been found to save the gardens from the effects of frost, as on such nights, there is some light wind which drifts away the screen of smoke and brings in fresh cold air from outside. Bright fires, therefore, arranged at 50 to 60 places to an acre may be the only effective means of protecting the gardens from the effect of frost.

(*c*) *Irrigation.*—At Ozar-Tambat, there is a big reservoir of water and tall trees all over the area. It was found that the effect of frost on vegetation was very little in this locality. This was also the experience in the last frost of

January 1929. This gave a clue that heavy irrigation on the nights of the cold wave should be resorted to, the water being let out the following morning. Later experience, however, has shown that irrigation does not help to any appreciable extent if frost continues longer than a day.

(*d*) *Wind-breaks*.—In the survey undertaken to estimate the damage to crops, it was observed that big trees or buildings standing in the directions of the cold currents of wind helped a great deal to mitigate the effects of frost. It is, therefore, recommended that in regions which are liable to the periodical occurrence of frost, thick wind-breaks of Shevri —10 feet away from the last row of trees in the plantations or permanent *tattis* 8 to 10 feet high may be put up in the usual direction of cold winds that blow in the months of January to February. This would directly thwart the cold current and tend to gradual warming after sunrise the next morning. This has been also advocated by the Department of Agriculture, Punjab, in their Leaflet No. 69.

REFERENCES

Bose, R. D. (1933). *Agric. and Live-stock in Ind.* **3**, 555-563.

Joshi, K. V. (1931). *Bull. Dept. Agric., Bombay*, 165 of 1930.

FACTORS GOVERNING YIELD OF CROPS (WOODHOUSE MEMORIAL PRIZE ESSAY, 1932)

BY

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Introduction

Yield may be defined as the final expression of the integration of the whole complex of physiological changes in the plant. Crops cover a wide range of special cases. The desired crop may be the fleshy part of the whole plant or its wood, fibre or bark. It may be some special morphological part as the petals of the rose, the fruits of the apple, the seeds of the pea, the seed-hairs of cotton, not to mention various tubers and roots. A crop may be agricultural, horticultural or a forest crop. It may be annual, biennial, semi-perennial or perennial.

The possibility of growing crops successfully is everywhere conditioned by a large number of factors. The differences in yield from field to field or from year to year, with no apparent cause, are traceable to the interplay of a large number of factors which exercise their influence in a variety of ways. An attempt is made here to consider them briefly under the following different heads :—

I. Climatic and seasonal conditions.

II. Soil conditions.

III. Cultivation methods.

IV. Planting material.

V. Pests and diseases.

VI. General economic conditions.

I. Yields as governed by climatic and seasonal conditions

It is well known that, in general, climate plays a very important part during the entire period of the growth of a plant. Climate is governed by the condition

of a tract or region in relation to the various phenomena as temperature, light, rainfall, wind and humidity.

Temperature is essential for assimilation, respiration, and growth of plants. The first two are affected directly by a rise in temperature but there is no steady increase with the increasing temperature. As the temperature is raised, they rise and fall without any reference to its intensity. The process of growth, however, shows a different response to either of these, in that it is directly proportional to temperature within certain limits. Extremes of temperature are, however, highly injurious to plant growth, the activity of the vital processes being checked considerably and the tissue getting either flaccid or turgid with disastrous results. Temperature frequently determines the kind of crop which can be grown in a country.

Light. Plants are sensitive both to the total intensity and the quality of light. Light is responsible for increased assimilation, respiration, transpiration, and absorption of atmospheric carbon-dioxide. It is also responsible for the formation of chlorophyll. Occasional cloudy weather is considered good to healthy growth while prolonged cloudy atmosphere is harmful.

Rainfall. Both the quantity and distribution are important in crop production. The vegetation in localities with high falls is often poor due to denudation and erosion.

In the early stages of growth the amount of water required is very small, but as growth proceeds the demand for water increases, reaching its maximum at flowering time and then gradually decreasing as ripening sets in. The possibilities of successful development of annual crops, therefore, depend on the distribution and amount of annual rainfall and also on the duration of crop. With perennials, however, it is the distribution that counts more than the total rainfall. Unusual showers, especially in off-seasons, favour undue development of pests and diseases leading to poor yields.

Winds. By far the most important of these, as far as the Indian conditions of agriculture are concerned, are the monsoon winds. There is a close relationship between rainfall and monsoon wind in so far as the latter is a precursor of the former. In crop yields, therefore, the need for their regularity is too evident to be emphasised.

Light breezes tend to increase transpiration resulting in the greater production of crops, while when exposed to strong winds, the vegetation is often stunted, due to excessive evaporation and injury to tender tissues.

Humidity. Other conditions remaining the same, the transpiration in plants is directly related to the evaporating power of the air.

Seasonal effect. Annual plants have their own well-defined seasons for their cultivation. If a crop is to be grown with the maximum benefit, it has to be cultivated in a particular season. In years of protracted spells of dry weather, the

seed of certain crops is sown even in dry soils to await rainfall or with the help of lift-irrigation. Experience has shown that crops when sown outside certain seasonal limits, rarely if ever, yield satisfactory returns, due perhaps to the deficiencies or excesses of requisite soil nutrients and unsuitable climatic conditions prevailing at such times.

II. Yields as governed by soil conditions

Soil conditions fall under three principal classes: (*a*) physical, (*b*) chemical and (*c*) biological.

(*a*) *Physical* conditions of the soil would include the texture, aeration, water-holding capacity, temperature and humus and colloidal contents of the soil.

Texture of the soil has a profound influence on the availability of soil ingredients to plants. Loose sands are too poor to yield satisfactory returns, while heavy clays are comparatively fertile and produce better crops; but a fine loam which generally possesses air, moisture, plant foods, etc., in right proportions often constitutes a good nursery for plants.

Air. In adequate quantities air is essential for root-respiration and for the biological processes that are incessantly going on in the soil. Crops in ill-drained water-logged soils suffer from want of sufficient air.

Water is present in the soil as (1) free water, (2) film water and (3) hygroscopic moisture. The first and the last are practically of no use to plants. It is the film water that is absorbed by plants. Soils differ in their water-holding capacity and it is on the amount of moisture retained as film that the development of root-system, and hence the growth, depends. Plants suffer as much from excess water as they do from insufficient supply, and their yield increases with moisture content within certain limits.

Temperature increases respiration and permeability of root hairs to soil solutions and is, in fact, essential for all the vital processes of the plant as also for the complex biological changes that are constantly taking place in the soil.

Humus and colloids. A combination of high water-holding capacity and rapid percolation characterises a fertile soil well supplied with humus and good tilth. The presence of humus and colloids in adequate quantities is of outstanding importance in view of the desirable improvements they bring about in soils.

(*b*) *Chemical.* Besides water, plants derive nitrogen and all the ash constituents from the soil. Of the constituents needed in quantities are nitrogen, phosphates and potash, and these are required in such large quantities that they have to be added to the soil as fertilizers, if maximum yields are sought for. The total amount of these plant food materials present, their availability and the absence of injurious substances are the three main factors controlling yield of crops.

Nitrogen. There is generally a close connection between the amount of this nutrient supplied and the plant growth. Its starvation is characterised by stunted growth and yellowish foliage ; but in excessive quantities it favours sterility by inducing rank growth which is often crinkled, soft, sappy and liable to insect damage and diseases. The crop lodges badly and there is retardation of ripening and loss of grain yield. It acts more beneficially in longer crops.

Phosphoric acid. Its most obvious effects are on the root-system, tillering of cereals and, thus, production of seed. It is best administered in root and grain crops. Phosphate starvation stunts growth, depresses tillering, reddens leaf colour with low yields of grain and straw. It is a nutrient of the nucleus, essential for cell-division and meristem tissue, for the normal transportation of carbohydrates and for the efficiency of chloroplast mechanism. Excess of this substance has a depressive effect on the yield.

Potash. It is associated with the efficiency of the leaf as an assimilator of carbon-dioxide, the making of plant substances and the utilization of synthesised carbohydrates. Its deficiency leads to yellowing of leaves and reduced production of sugars and starches per unit area. It is essential in the reduction of nitrates, for the formation of proteins and facilitates adequate supplies of water to the plant by increasing root development. It is the counterpart of nitrogen and is associated with the size of leaf, the two nutrients being intimately linked together in their action. Neither of the fertilizers gives full effect without the adequate supplies of the other.

Other ingredients. They are of minor importance. Crops do not come up well on soils deficient in calcium. The presence of boron in appreciable quantities stimulates plant growth.

Effects of injurious substances. Plants do not grow well on acid and alkaline salts, 'OH'-ions being more toxic than the 'H'-ions. The acidity of roots diminishes as the nitrogen-supply decreases.

(c) *Biological.*—The soil is not a dead mass receiving on the one hand manure which it passes on to the crop by purely chemical or mechanical processes, it is rather a busy and complex laboratory where a multitude of minute organisms are always at work. By the action of some of these organisms vegetable residues and manures are digested to a condition in which they will serve as food for plants. Others are capable of fixing atmospheric free nitrogen ; others again are destructive to the food stores in the soil. It is evident that conditions tending to increase the number of favourable organisms in the soil will naturally increase the crop yields.

III. Yields as governed by cultivation methods

Preparatory cultivation. To bring about the conditions necessary for the reception of crops and their successful growth the soil must exist in a fine state of division ; it must be clean and free from weeds and must contain sufficient supplies

of plant food and moisture. Towards this end the soil has got to be loosened and turned over so as to allow air, rain, frost, wind and sunshine to exercise their pulverising influence.

Tillage operations fall into two principal classes :—(*i*) deep cultivation and (*ii*) surface cultivation. The objects of deep cultivation are : (*a*) to break the soil aggregates, (*b*) to facilitate the absorption of moisture, (*c*) to regulate the lift of water from the sub-soil, (*d*) to reduce surface evaporation, (*e*) to provide more room for root development, (*f*) to improve aeration, (*g*) to facilitate weathering action ; while the objects of surface cultivation are : (*a*) to remove weeds and (*b*) to reduce evaporation. Methods of cultivation must necessarily be modified according to the nature of crops.

Seed and sowing. Seed should be plump and sowing should be done when the soil is in right condition in regard to tilth and moisture. Good yields are obtained with economic seed-rate and uniform spacing. To effect good germination, sometimes the soil has got to be compressed after sowing, otherwise the germination will be poor, the stand patchy and yield low. In some cases shading is necessary in the early stages as in tobacco.

Manures and manuring. The requirements of the soil and the crop should be known before manuring is done. All the plant nutrients must be present in the soil in adequate quantities if maximum crop returns are aspired for. Economic and judicious manuring should always be aimed at. The use of organic manures generally results in best yields being obtained due to its influence on the physical texture besides its additive effect. Green-manuring, in conjunction with phosphates, is considered to be the most effective and economic way of manuring most of the crops in this country. Untimely applications are always un-economical and often act adversely.

Irrigation and drainage. They are essentially meant to control soil moisture. Water starvation retards growth and hastens maturity. Copious waterings at considerable intervals in some cases are found to be most conducive to plant growth than frequent light waterings, as better utilization of water and better aeration are ensured in the former case. Fruits and vegetables crack badly with excess watering. Available water-supply largely determines the nature of crops to be grown in particular localities.

Drainage removes excess water from the surface soil which would otherwise cause root asphyxiation and interfere with the biological process of the soil. Ill-drainage arrests growth and favours diseases. In wet crops, such as rice, excess drainage has been proved to give poor yields.

After-cultivation. It includes a variety of operations, *viz.*, thinning, weeding, interculture, propping, pruning. Plant growth and crop yield correspond directly with the promptness and thoroughness with which these operations are carried out during their stand in the field.

Harvesting. It should be done at the right time; if done earlier, the quality deteriorates in addition to loss in weight. If allowed to become over-ripe, considerable loss is incurred by shedding. Economic and efficient methods of harvesting and threshing will reduce wastage and thereby enhance crop yields.

Rotation. If practised judiciously it increases crop yields. It results in (*a*) crops of greater vigour, (*b*) economy in the use of manures, (*c*) economical distribution of animal and human labour, (*d*) neutralization of toxins produced by crops, (*e*) keeping down pests and fungal diseases, (*f*) storing food materials as by legumes. In some crops, such as rice, the practice of rotation is not necessary. In the permanent plantations it is difficult to think of rotation.

Fallowing. Occasional resting of land especially under dry-farming conditions is necessary to maintain the land in a uniform state of productivity. Continuous cropping makes the land sick and minimises crop returns.

Burning, warping, marling, liming, etc., are occasionally resorted to in order to improve the condition of the soils for increased crop production.

IV. YIELDS AS GOVERNED BY PLANTING MATERIAL

One of the first essentials in the cultivation of crops is that the planting material should be of satisfactory quality and the success of the undertaking largely depends upon this factor. Crops may be raised either from seed or by a variety of vegetative methods, ranging from simple process such as the planting of suckers or tubers, to the more complicated operations like grafting, in which a considerable amount of skill is required. The improvement of this planting material, which is achieved by plant-breeding methods, constitutes a potent factor in crop production. The science of plant-breeding aims at improving the potential yielding power of the plant. The importance of this factor in crop production can best be appreciated if one realises that " a monetary gain from improved varieties in India alone is estimated to be ten and a half crores a year ".* The breeding methods fall under four main classes.

(1) *Introduction and acclimatization.* Improvement in crop yields is sometimes aimed at by introducing reputed varieties from other countries. Excellent results have sometimes been obtained by this method. In Madras the cultivation of sugarcane, which was on the verge of extinction due to red-rot, was resuscitated by the timely introduction of varieties from Barbados, Java and Mauritius. The introduction of the ' Adcock ' tobacco has opened a new chapter in the tobacco industry of India. Success depends upon how the imported variety responds to the altered climatic and soil conditions. Exotic varieties are generally late; Indian conditions, on the other hand, demand quick establishment and early ripening of crops. This problem, however, can be overcome by hybridization.

* Mrs. Gabrielle L. C. Howard, M.A.,—Presidential address: " The Improvement of Plant ", Proceedings of the 16th Indian Science Congress, Madras, 1929.

(2) *Selection.* Varieties are improved by mass-selection in which the planting material selected is of uniformly superior quality to the rest of the crop. Increased yields are undoubtedly obtained by this method, yet this cannot be said to be the ideal system of improving varieties. Pure-line selection is, by far, the superior method. Promising single plants are selected from the standing bulk crop, tested for purity and superiority over the standard from which they are selected, and then distributed for general cultivation. Pusa wheats, Bengal and Madras rices and Central Provinces cottons afford excellent examples.

(3) *Hybridization.* The outstanding advantage which this method can claim is the successful combination of desirable characters. The hybrids produced by artificial crossings are fixed, compared with the local standards and finally released for the benefit of the cultivators as has been done in the case of Pusa hybrid wheats. Increased yields are aimed at by taking advantage of hybrid vigour of the first filial generation by clonally propagating them as is evidenced in certain of the Coimbatore seedling canes.

(4) *Other methods.* Desirable combinations for increased crop production have been brought about by grafting good yielders or desirable bud variations on to the better resistant but poor yielders, to suit the varying soil and climatic conditions as in mangoes and other fruit trees.

V. Yields as governed by pests and diseases

The agencies responsible for the destruction of plants comprise mainly: (*i*) living organisms either animal or vegetable pests, (*ii*) unsuitable environment. A pest is a disease causing organism whether plant or animal. Pests live as parasites upon or within the body of their hosts, from which they derive all or part of their food. Some pests may bring about the death of their host in a very short time, while others, although not actually killing their host, may, nevertheless, interfere with its growth and reproduction, reduce its vitality and open the way for attack by other organisms.

Animal pests. Wild animals such as jackals, wild boars, etc., rodents such as rats, rabbits, wood chucks, etc., and birds often prove extremely troublesome to the standing crop. The loss can considerably be mitigated by a variety of ways such as fencing, trapping, shooting and scaring away by fires, etc.

Insects. They cause considerable damage to crops. The loss through this source in this country is estimated to be Rs. 2,000,000,000 (one and a half times the revenue of the Government of India)*. Many control measures which are either preventive or remedial have been developed, but their success depends upon the co-operation amongst cultivators, as otherwise the pest easily re-appears on the treated fields from the neighbouring untreated ones.

Some insects are beneficial. Some species of Hymenoptera help pollination in certain plants and some of them are parasitic on injurious insects, while some

* Note to the Industrial Commission by T. Bainbrigge Fletcher. Appendix 1916.

species of Coleoptera help aeration in the soil by burrowing in and some Hemiptera destroy weeds and poisonous plants.

Nematodes. Rice, wheat, tobacco, tomatoes and several other green and vegetable crops suffer from the ravages of these worms. Clean cultivation and soil treatment with some mercury compounds or calcium cyanamide may prove useful.

Weeds and parasitic plants. Crops also suffer from these pests, the former causing injury by absorbing nutrients available for the crop plants and limiting the space for their development while the latter by sucking the plant sap directly and by harbouring other pests and diseases.

Fungi. Diseases due to fungi are a legion. The rusts, smuts, the leaf-spots, the wilts, the root-rots, seedling blights, the stem-rots are mostly due to depredations by fungi. In those cases where the diseases are borne by seed, effective seed treatment has been developed as treating sorghum with copper sulphate solution. Leaf-spots, stem-rots and some rusts have been controlled by spraying with fungicides, while, in others control has been secured by evolving resistant types, as Pusa wheats and *rahars*.

Bacteria. These cause wilts, leaf-spots, seedling blight and cankers. Wilt diseases due to bacteria are common on tobacco, potato, tomato and other solanaceous plants. Here again seed and soil treatment or use of fungicides are useful in controlling these diseases.

Virus diseases. These have been newly recognized, the size of the causing entity being outside the bounds of the microscope. Chillies, tomatoes, sugarcane, sandal-wood plants and several others suffer from ravages of these diseases. Breeding of resistant lines appears to be the only remedy.

Excess or deficiency of nutrients or moisture in soil cause diseases ; by correcting the excess of moisture by draining and the deficiency by application of the requisite ingredients, normal crops can be grown.

VI. Yields as governed by general economic conditions

Apart from the agricultural factors governing the yield of crops, there are certain other considerations, purely social and economic, which play a very important part in the development of the general conditions of agriculture and its practices. In India the first and foremost is the small holding upon which a cultivator has to depend for his livelihood. The land tenure system and the laws of inheritance are chiefly responsible for such fragmentation, but this also has a remedy for it. Co-operative cultivation and marketing systems with the labour available from the co-operative society itself are perhaps most efficient to secure very high yields of crops through the employment of modern agricultural practices. This has been achieved in Holland with significant success.

Absence of suitable marketing facilities and of the knowledge of the extent of demand for particular commodities serve as a stumbling block in the march of agricultural progress. Once a cultivator has known the available facilities, he will strain every nerve to secure a crop of the type wanted.

Prices for farm products play an important role in crop production. When prices go high, the cultivators naturally give more attention to their farming and this obviously results in greater production of crops.

Poverty and resulting debt may also influence the final yield of crops. Greater yields can undoubtedly be obtained by the employment of efficient machinery or labour. This, however, necessitates investment of more money which under Indian conditions of poverty and bankruptcy seems improbable if not impossible.

Intensive research and dissemination of results of proved value to cultivators by broadcasting or by exhibitions, as is now practised in European countries and America, and offering of prizes for the best agricultural exhibits are bound to operate towards increased interest in cultivation. Mass education especially in agriculture and intensive agricultural practices on approved lines will surely enhance crop production in India.

LITERATURE CONSULTED

Babcock, E. B. and Clausen, R. E. (1927). Genetics in relation to Agriculture.

Bailey, L. H. (1908). The principles of plant culture.

Conference of Empire Meteorologists, 1929, Agriculture Section II. Papers and Discussions.

Fream, W. Elements of Agriculture.

Hall, A. D. (1909). The Soil.

Hays, H. K. and Garber, R. J. (1927). Breeding crop plants.

Howard, A. (1924). Crop production in India.

Keen, B. A. The physical properties of the soil.

Lundegardh, H. (Translated by E. Ashby). Environment and plant development (1931).

Martin, H. The scientific principles of plant protection.

Maximov, N. A. (Translated by R. H. Yapp). The plant in relation to water.

———— (Translated by R. H. Yapp). A text book of plant physiology.

Proceedings of the International Congress of Plant Sciences, Ithaca, 1926—Vols. I and II.

Russell, E. J. Plant nutrition and crop production.

———— (1921). Soil conditions and plant growth.

Tempany and Mann. Principles of tropical agriculture.

Waksman, S. A. and Starkey, R. L. The soil and the Microbe.

SOME ASPECTS OF MARKETING AND COST OF TRANSPORTATION OF COTTON

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Preface

This paper contains the results of a part of research work carried out by Messrs, Ajaib Singh, B.Sc. (Agri.), and Partap Singh, B.Sc. (Agri.), Scholars of the Indian Central Cotton Committee.

These scholars attended the full course of lectures in economics with the M.A. classes of the Punjab University, Lahore, which formed a background for the research work which they carried out under the guidance of the undersigned for the remaining two years. Two of their papers, namely,

(1) Report on an enquiry into the local consumption of *kapas* in the Lyallpur district in 1930-31 and

(2) Report on an inquiry into the sources of seed supply of cotton in the Lyallpur District for the year 1930-31 and 1931-32,

have already been published in Vol. III, Part VI, of this *Journal*. The Indian Central Cotton Committee paid the scholarships of these scholars; their travelling expenses were paid by the Punjab Government.

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Introduction

This paper is the outcome of an enquiry conducted to ascertain the conditions under which *kapas* (seed-cotton) is transported from villages to the Lyallpur market for sale. The main object of the inquiry was to see if there is any difference in the cost of transportation of *kapas* on metalled and unmetalled roads. Later, it was decided to include some other points in connection with the marketing of *kapas* that could be easily investigated along with the main inquiry. A copy of the questionnaire drawn up for this purpose is given in the Appendix.

The Lyallpur market selected for this inquiry is the most important cotton market in the canal colonies of the Punjab. Four metalled and eight unmetalled roads converge into the town from various parts of the district. The area served by the market is extensive, sometimes extending as far as 33 miles, and covering some parts of the adjacent district of Jhang as well.

Period covered by the inquiry.—The inquiry was commenced in November, 1931, and continued till April, 1932, thus covering practically the whole of the cotton season. During this period visits were paid to the market frequently though not daily, because along with this inquiry other research work in connection with the determination of boll-weight was also being carried out.

Transportation of kapas.—*Kapas* in the Lyallpur district is transported mostly in carts. Some *kapas*, especially that from Jhang district, also comes on camels. The carts used for the transport of *kapas* are provided with gunny cloth sides called *pallis*. *Kapas* is loaded in carts a day before it is to arrive in the market. The cartmen start early or late in the night according to the distance they have to cover, so as to reach the market before noon the next day. The carts loaded with *kapas* travel 2 to 2½ miles an hour.

Marketing of cotton.—There are two markets at Lyallpur for the sale of wheat, oil-seeds, *gur*, etc. They are situated in the town. Cotton is not sold there because there is not sufficient space for the carts to stand. *Kapas*, therefore, is sold outside the town in front of the cotton ginning and pressing factories. The carts arriving in the morning line up in front of the factories. The representatives of buyers start their inspection of carts at about ten and go on doing this till 12 noon, when the actual sales begin. The *Artis* (commission agents) come from the market to take part in the sales on behalf of the sellers. The buyers go to each cart or carts belonging to one owner and give their bids under cover of a cloth to the commission agent who represents the seller. Each lot goes to the highest bidder. The carts that are sold are taken to the factories where actual weighing of *kapas* takes place. The carts and cartmen are sometimes not free to go until late in the evening.

As regards the loads carried on return journey, the cartmen, most of whom were cultivators from the villages, and had as a matter of course to return to their villages, were asked in the morning if they expected to carry any load while returning. Out of a total of 954 cartmen only 174 (*i.e.* 18·2 per cent) replied in the affirmative. It was not possible to obtain this information as to the actual loads carried because the carts left the town in the evening from different places and in different directions.

Proportion of kapas *brought to the market by growers and by middlemen* —The following table gives the number of cartloads belonging to the growers and middlemen separately for each month of the inquiry. The carts were selected at random. The figures, therefore, give a fairly representative idea of the proportion of two classes of carts brought to the market :—

Month	Total No. of carts	Carts belonging to		Percentage of	
		Cultivators	Middlemen	Cultivators' carts to the total	Middlemen's carts to the total
November	333	44	289	13·2	86·8
December	94	20	74	21·3	78·7
January	39	18	21	46·2	53·8
February	192	51	141	26·6	73·4
March	177	65	112	36·7	63·3
April	119	52	67	43·7	56·3
Total	954	250	704	26·2	73·8

As will be seen from this table the percentage of cultivators bringing their own cotton to the market was on an average 26·2. It was very low in the beginning of the season (13 per cent), but later on it went up considerably (46 per cent). This shows that cultivators do not bring their *kapas* directly to the market till late in the season when they have picked enough cotton to make full loads for their carts and have also more leisure.

The proportion of the cartloads brought to the market by middlemen and cultivators might be taken as a criterion of the extent to which the cultivators sold their *kapas* through the middlemen. But as the average weight of a middleman's and cultivator's cartload might not be the same, the quantity of *kapas* marketed by the two kinds of sellers was also ascertained. The total weight of 363 cartloads, the weight of which could be ascertained from the commission agents, was 9,656 mds. 38 srs. Of this 2,290 mds 2 srs or 22·7 per cent was brought by the producers themselves and 7,366 mds. 36 srs. or 76·3 per cent by the middlemen.

In order to see the effect of distance on the proportion of *kapas* marketed by cultivators and middlemen, the following table was prepared. The carts have been divided into three classes, *viz.*—

(1) Coming from places within 10 miles of the market.

(2) From 11 to 20 miles of the market.

(3) From over 20 miles.

Distance from the market	Total No. of carts	Carts belonging to		Percentage of	
		Cultivators	Middlemen	Cultivators' carts to the total	Middlemen's carts to the total
Up to 10 miles . .	159	73	86	45·9	54·1
11 to 20 miles . .	561	134	427	23·9	76·1
Above 20 miles . .	234	43	191	18·4	81·6
Total .	954	250	704	26·2	73·8

It would be seen that the percentage of *kapas* brought to the market directly by the producers decreases as the distance from the market increases. Cultivators within 10 miles of the market sold 45·9 per cent of their cotton directly in the market. In the case of those living within 11 to 20 miles and over 20 miles from the market the percentage of cotton sold direct in the market came to 23·9 and 18·4 respectively.

Load per cart.—A cart on an average carried 26 mds. 29 srs. of *kapas.* Loads during this inquiry were observed to vary from 9 mds. to 40 mds. 37 srs. The weights of cartloads belonging to middlemen and growers are given in the following table: –

Owner of *kapas*	Minimum load		Maximum load		Average load	
	Mds.	Srs.	Mds.	Srs.	Mds.	Srs.
Cultivator	9	0	38	7	25	7
Middleman	10	32	40	37	27	3

The average load per cart on metalled roads was 28 mds. 39 srs. and on unmetalled roads 24 mds. 7 srs.

Distance travelled by carts.—The total mileage travelled by 954 carts came to 15,391 miles of which 6,893 miles were on metalled and 8,498 miles on unmetalled roads. This comes to 16·1 miles per cart (7·2 miles on metalled and 8·9 miles on unmetalled roads). The maximum distance travelled by a cart was 33 miles.

Cost of transportation.—Freight is charged by cartmen at a certain rate per maund, which depends on the distance of a place from the market. The average

rate per maund for all carts travelling on an average 7·2 miles on metalled and 8·9 miles on unmetalled roads comes to Re. 0-3-4, which comes to 2·5 pies per mile.

Effect of distance and the nature of road on the cost of transportation.—In order to study the effect of distance on the cost of transportation it was essential to eliminate the effect of the nature of road. For this purpose only those carts were taken which travelled the entire distance either on metalled or unmetalled roads. The relative data is given in the following table :—

Distance travelled	Metalled road				Unmetalled road				Percentage increase in the cost of transportation over unmetalled roads expressed as percentage of cost over metalled roads.
	Average distance	Rate per md.		Rate per md. per mile	Average distance	Rate per md.		Rate per md. per mile	
	Miles	As.	Ps.	Pies	Miles	As.	Ps	Pies	
Up to 10 miles . .	6·2	2	0	3·9	8·1	2	10	4·2	7·7
11 to 20 miles . .	14·2	3	0	2·5	15·7	3	7	2·7	8·0
Above 20 miles . .	25·5	3	2	1·5	24·4	4	1	2·0	33·3
Average .	12·1	2	8	2·6	15·5	3	6	2·7	3·9

From the above table it would be seen that the rate charged per maund for transportation increases with the increase in distance, though not proportionately. This is but natural as the cartmen have to load the *kapas* on the carts themselves and have also to wait in the market until the *kapas* is weighed, which takes the same time for all carts irrespective of the distance travelled by a cart. The cartman, therefore, bases his charges on the total time he spends and not on the time he actually spends in travelling alone.

From this table it would further be observed that the nature of the road does not affect materially the cost of transportation when the distance to be travelled is not very long. Up to 10 miles the cost of transportation on unmetalled roads is only 7·7 per cent higher than that on metalled roads. In the case of distance above 20 miles it is 33 per cent more. It may, however, be noted that the season when *kapas* is marketed is dry.

Difference between village and market rates.—Difference between the village and the market rates of *kapas* is due to transport charges, marketing expenses, and the risk which the middleman has to take.

In order to find the difference between the two prices the price of *kapas* sold in villages on the previous day was ascertained from the owners and the cartmen. These prices were then compared with the prices which ruled on the same day in the Lyallpur market (Appendix II). The difference between the rates was as follows :—

	Desi cotton			American cotton		
Average rate per maund in the village (Rs.) . .	5	14	2	7	4	5
Average rate per maund in the market ,, . .	6	6	7	7	14	1
Difference . . . . . . ,, . .	0	8	5	0	9	8
Percentage of difference to the village rate . .	8·9			8·3		

Thus, on an average, the prices of *Desi* and American cottons were lower in the villages by Re. -/8/5 and Re. -/9/8 per maund respectively. The average cost of transportation comes to Re. -/3/4 per maund. To this must be added about Re. -/3/9 per maund for *Desi* and Re. -/4/6 per maund for American cotton for expenses incurred in the market. The total cost of transportation and marketing, therefore, comes to Re. -/7/1 for *Desi* and Re. -/7/10 for American cotton. It thus leaves Re. -/1/4 per maund in *Desi* and Re. -/1/10 per maund in American cotton as the profit of the village middleman. This does not seem to be an excessive profit for all the trouble and risk he has to take.

Carts hired or owned.—As stated previously, 26·2 per cent of the carts investigated belonged to cultivators and 73·8 per cent to middlemen. It was found that not all the cultivators brought their *kapas* on their own carts and not all middlemen on hired ones. Eleven carts (=4·4 per cent of the carts bringing growers' cotton) were found to be hired by the growers who brought their *kapas* to the market. In the case of middlemen 78 carts (=11·2 per cent of the carts bringing middlemen's cotton to the market) were their own.

The benefit of transportation of *kapas*, however, goes mostly to the agriculturist. Of the 954 carts investigated only 13 or 1·4 per cent belonged to professional cartmen, the remaining 941 carts (98·6 per cent) belonged to the cultivators who supplemented their income from cultivation by plying carts.

Main conclusions

1. Only 22·7 per cent of *kapas* that came to the market belonged to the growers, the rest of it was marketed through middlemen.

2. In the beginning of the season more cotton came to the market through middlemen. As the season advanced the proportion of *kapas* marketed direct by growers increased.

3. A greater proportion of *kapas* grown in the neighbourhood of the market is marketed directly by the growers. From long distances more cotton comes to the market through middlemen.

4. Average load per cart came to 26 mds. 29 srs. and the average distance travelled to 16·1 miles.

5. Nature of the road does not affect the cost of transportation very much for short distances. It has its effect, however, for long distances.

6. Difference between the village and the market rates, after deducting the cost of transportation and marketing was found to be Re. -/1/4 per maund in *Desi* and Re. -/1/10 per maund in American cotton, which works out to be about 1·5 per cent of the village prices and does not appear to be excessive considering the risk and trouble involved in marketing.

APPENDIX I

Questionnaire for investigation into some aspects of marketing and cost of transportation of cotton

1. Date.
2. Name of the market.
3. Seller of *kapas* :—
   (*a*) Name.
   (*b*) Residence.
   (*c*) Profession (zamindar or a shopkeeper).
4. Name of the commission agent.
5. Weight of *kapas* in the market.
6. Means of conveyance :—
   (*a*) What conveyance used.
   (*b*) Hired or owned.
   (*c*) If hired, the hire rate per maund.
   (*d*) If owned, the rate charged by other cartmen from that village during those days.
   (*e*) Is the owner of the conveyance a professional conveyor or practises it only as a subsidiary business ?
7. Means of communication :—
   (*a*) Small village road—miles.
   (*b*) Unmetalled District Board road—miles.
   (*c*) Metalled road—miles.
8. General :—
   (*a*) The price at which the cotton is sold.
   (*b*) Load to be carried on return journey, if any.
   (*c*) Village rate.

APPENDIX II (A)

The difference of village and market prices of **Desi** *cotton*

Serial No. of a quotation from a village	Date	Village price			Market price			Difference		
		Rs.	.	.	Rs.	A.	P.	Rs.	A.	P.
1	4th November 1931	5	4	0	6	2	0	0	14	0
2	Ditto	5	4	0	6	2	0	0	14	0
3	Ditto	5	2	0	6	2	0	1	0	0
4	Ditto	5	4	6	6	2	0	0	13	6
5	Ditto	5	6	6	6	2	0	0	11	6
6	5th November 1931	5	8	0	5	15	9	0	7	9
7	Ditto	5	8	0	5	15	9	0	7	9
8	Ditto	5	8	0	5	15	9	0	7	9
9	Ditto	5	8	0	5	15	9	0	7	9
10	Ditto	5	8	0	5	15	9	0	7	9
11	6th November 1931	5	6	0	5	13	3	0	7	3
12	Ditto	5	8	0	5	13	3	0	5	3
13	Ditto	5	8	0	5	13	3	0	5	3
14	Ditto	5	8	0	5	13	3	0	5	3
15	Ditto	5	4	0	5	13	3	0	9	3
16	Ditto	5	8	0	5	13	3	0	5	3
17	7th November 1931	5	4	0	5	14	0	0	10	0
18	Ditto	5	9	0	5	14	0	0	5	0
19	Ditto	5	9	0	5	14	0	0	5	0
20	Ditto	5	8	6	5	14	0	0	5	6
21	Ditto	5	10	0	5	14	0	0	4	0
22	9th November 1931	5	10	0	5	13	0	0	3	0
23	12th November 1931	5	11	0	5	12	0	0	1	0
24	13th November 1931	5	8	0	5	14	3	0	6	3
25	18th November 1931	5	10	0	6	2	0	0	8	0
26	Ditto	5	11	0	6	2	0	0	7	0
27	Ditto	5	8	0	6	2	0	0	10	0
28	Ditto	5	8	0	6	2	0	0	10	0
29	19th November 1931	5	0	0	6	2	0	1	2	0
30	Ditto	5	12	0	6	2	0	0	6	0
31	20th November 1931	5	6	0	6	2	0	0	12	0
32	Ditto	5	11	0	6	2	0	0	7	0
33	21st November 1931	5	10	0	6	2	0	0	8	0
34	Ditto	5	10	0	6	2	0	0	8	0
35	23rd November 1931	5	10	0	6	4	0	0	10	0
36	24th November 1931	5	8	0	6	2	0	0	10	0
37	Ditto	5	8	0	6	2	0	0	10	0
38	Ditto	5	8	0	6	2	0	0	10	0
39	26th November 1931	5	8	6	6	2	0	0	9	6
40	27th November 1931	6	0	0	6	7	0	0	7	0

Serial No. of a quotation from a village	Date	Village price			Market price			Difference		
		Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
41	10th December 1931 . .	6	2	6	7	6	0	1	3	6
42	Ditto . .	7	4	0	7	6	0	0	2	0
43	Ditto .	6	12	0	7	6	0	0	10	0
44	Ditto . .	6	8	0	7	6	0	0	14	0
45	Ditto . .	6	8	0	7	6	0	0	14	0
46	16th December 1931 . .	6	4	0	6	12	0	0	8	0
47	27th January 1932 . .	7	0	0	7	12	0	0	12	0
48	23rd February 1932 . .	6	13	0	7	8	0	0	11	0
49	Ditto . .	7	2	0	7	8	0	0	6	0
50	Ditto . .	7	2	0	7	8	0	0	6	0
51	23rd February 1932 .	6	4	0	7	8	0	1	4	0
52	27th February 1932 .	7	2	0	7	4	0	0	2	0
53	2nd March 1932 . .	7	2	0	7	6	0	0	4	0
54	3rd March 1932 . .	7	0	0	7	1	0	0	1	0
55	Ditto . .	7	0	0	7	1	0	0	1	0
56	Ditto . .	6	12	0	7	1	0	0	5	0
57	4th March 1932 . .	6	4	0	7	0	0	0	12	0
58	Ditto . .	6	10	0	7	0	0	0	6	0
	Total .	341	6	6	371	15	6	30	9	0
	Average .	5	14	2	6	6	7	0	8	5

APPENDIX II (B)

The difference of village and market prices of American cotton

Serial No. of a quotation from a village	Date	Village price Rs.	A.	P.	Market price Rs.	A.	P.	Difference Rs.	A.	P.
1	10th November 1931 . .	6	12	0	7	5	0	0	9	0
2	13th November 1931 . .	6	8	0	7	4	0	0	12	0
3	Ditto . .	6	8	0	7	4	0	0	12	0
4	Ditto . .	6	8	0	7	4	0	0	12	0
5	Ditto . .	6	12	0	7	4	0	0	8	0
6	Ditto . .	6	14	0	7	4	0	0	6	0
7	14th November 1931 . .	6	0	0	7	2	6	1	2	6
8	18th November 1931 . .	6	12	0	7	7	0	0	11	0
9	19th November 1931 . .	6	8	0	7	4	0	0	12	0
10	Ditto . .	6	10	0	7	7	0	0	13	0
11	20th November 1931 . .	6	11	0	7	4	0	0	9	0
12	Ditto . .	6	10	0	7	4	0	0	10	0
13	Ditto . .	6	8	0	7	4	0	0	12	0
14	Ditto . .	6	8	0	7	4	0	0	12	0
15	Ditto . .	6	11	0	7	4	0	0	9	0
16	21st November 1931 . .	6	12	0	7	4	0	0	8	0
17	23rd November 1931 . .	6	10	0	7	4	0	0	10	0
18	Ditto . .	6	8	0	7	4	0	0	12	0
19	24th November 1931 . .	6	8	0	7	6	0	0	14	0
20	Ditto . .	6	8	0	7	6	0	0	14	0
21	Ditto . .	6	8	0	7	4	0	0	12	0
22	Ditto . .	6	2	6	7	4	0	1	1	6
23	Ditto . .	6	0	0	7	4	0	1	4	0
24	26th November 1931 . .	7	0	0	7	8	0	0	8	0
25	Ditto . .	7	0	0	7	8	0	0	8	0
26	Ditto . .	6	8	0	7	4	0	0	12	0
27	27th November 1931 . .	6	14	0	7	5	0	0	7	0
28	Ditto . .	6	14	0	7	5	0	0	7	0
29	10th December 1931 . .	8	4	0	8	12	0	0	8	0
30	Ditto . .	8	8	0	8	12	0	0	4	0
31	Ditto . .	8	8	0	8	12	0	0	4	0
32	Ditto . .	8	4	0	8	12	0	0	8	0
33	Ditto . .	7	12	0	8	12	0	1	0	0
34	16th December 1931 . .	7	2	0	7	12	0	0	10	0
35	Ditto . .	7	5	9	7	12	0	0	6	3
36	Ditto . .	7	4	0	7	12	0	0	8	0
37	Ditto . .	7	4	0	7	12	0	0	8	0
38	Ditto . .	7	4	0	7	12	0	0	8	0
39	17th December 1931 . .	7	0	0	7	12	0	0	12	0
40	Ditto . .	7	2	0	7	12	0	0	10	0

Serial No. of a quotation from a village	Date	Village price			Market price			Difference		
		Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
41	25th January 1932 . .	8	2	0	8	8	0	0	6	0
42	23rd February 1932 . .	8	1	0	8	12	0	0	11	0
43	Ditto . .	8	4	0	8	12	0	0	8	0
44	Ditto . .	8	3	0	8	12	0	0	9	0
45	Ditto . .	8	2	0	8	12	0	0	10	0
46	Ditto . .	8	4	0	8	12	0	0	8	0
47	Ditto . .	8	4	0	8	12	0	0	8	0
48	24th February 1932 . .	7	8	0	8	6	0	0	14	0
49	Ditto . .	7	8	0	8	6	0	0	14	0
50	Ditto . .	7	12	0	8	6	0	0	10	0
51	Ditto . .	8	0	0	8	6	0	0	6	0
52	Ditto . .	8	0	0	8	6	0	0	6	0
53	25th February 1932 . .	7	4	0	8	6	0	1	2	0
54	Ditto . .	8	4	0	8	6	0	0	2	0
55	Ditto . .	8	0	0	8	6	0	0	6	0
56	26th February 1932 . .	8	2	0	8	8	0	0	6	0
57	27th February 1932 . .	8	3	0	8	10	0	0	7	0
58	3rd March 1932 . .	8	0	0	8	6	0	0	6	0
59	Ditto . .	8	0	0	8	5	0	0	5	0
60	Ditto . .	8	0	0	8	5	0	0	5	0
61	Ditto . .	7	12	0	8	5	0	0	9	0
	Total .	443	11	3	480	10	6	36	15	3
	Average .	7	4	5	7	14	1	0	9	8

STUDY OF AGRICULTURAL CONDITIONS UNDER WHICH *DESI* AND AMERICAN COTTONS ARE GROWN IN THE LYALLPUR DISTRCT

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Introduction

Being one of the important money crops in the Canal Colonies of the Punjab, cotton has naturally received a good deal of attention from the Agricultural Department. One of the improvements, brought about by the Department, is the introduction of American cotton in the Punjab. The area under this cotton expanded rapidly in the beginning, but it began to shrink after 1926, which was a year of partial failure for the American cotton. Some cultivators gave up its cultivation entirely, whereas others replaced it partly by *Desi* cotton. At present, there are many cultivators who grow both *Desi* and American cottons more or less side by side. It was, therefore, considered that a study of the agricultural conditions under which these two cottons are grown by the cultivators would be interesting from the economic as well as the commercial point of view. For this reason, the enquiry, the results of which are given in this report, was undertaken under the guidance of the Professor of Agriculture, Punjab Agricultural College, Lyallpur.

Method of enquiry.—Before starting the enquiry, the following questionnaire was drawn up to obtain the required information.

Questionnaire—

1. Name of the village.
2. Name of the cultivator.
3. Area under cotton of each farmer interrogated.
   (a) *Desi* cotton.
   (b) American cotton.
4. Total outturn of seed-cotton in maunds.
   (a) *Desi* cotton.
   (b) American cotton.

5. Condition of soil, *viz.*, whether condition of soil was same for both or better for American than *Desi*.
6. Number of irrigations :—
   (*a*) *Desi* cotton.
   (*b*) American cotton.
7. Name of the preceding crop in case of
   (*a*) *Desi* cotton,
   (*b*) American cotton.
8. Manuring—directly to cotton and indirectly to the crop preceding cotton in the case of (*a*) *Desi*, (*b*) American. Kind of manure and quantity if possible.
9. Number of hoeings and inter-ploughings in case of (*a*) *Desi*, (*b*) American.

A number of villages, in which both *Desi* and American cottons are grown, were selected tentatively in consultation with the District Work Staff. The investigator then went to these villages and interrogated cultivators individually to elicit the required information. As is usual in such enquiries, the cultivators, at first, suspected the motive of the enquiry when they were asked to give the figures of yield of *kapas* (seed-cotton). But when the real motive was explained some of them, who were intelligent, consented to give the information. Even then it is possible that the figures of yield given by them may be lower than the actual; but it does not affect this enquiry, because it would be same for both *Desi* and American cottons.

The enquiry lasted from February to middle of July, 1933. Sixty-four villages were visited and 953 cultivators interrogated.

The total area dealt with in this enquiry was 4747 acres. Of this area, 2555 acres were under *Desi* cotton and 2192 acres under American cotton.

The average yield per acre of both these cottons is set out in the following table (weighted mean yield per acre).

Desi cotton			American cotton		
Total area	Total outturn of seed-cotton	Outturn per acre	Total area	Total outturn of seed-cotton	Outturn per acre
Acres	Mds.	Mds.	Acres	Mds.	Mds.
2,555	11,453¼	4·48	2,192	11,737¼	5·35

In the preceding table are given the average yields of all the farmers interrogated. In individual cases, the yield varied from 1 md. to 28 mds. per acre in case of *Desi* cotton, and 1 to 24 mds. per acre in case of American cotton. The frequency of various levels of yield is contained in the table given below :—

Yield per acre in maunds	*Desi* cotton		American cotton	
	Actual area yielding	Per cent to total area	Actual area yielding	Per cent to total area
	Acres		Acres	
Up to 1 maund . . .	73¾	2·9	14¼	0·7
Above 1 to 2 mds. . .	206	8·1	136¾	6·24
,, 2 to 3 ,, . .	426	16·7	265½	12·1
,, 3 to 4 ,, .	570	22·3	414	18·9
,, 4 to 5 ,, . .	491¼	19·2	325	14·82
,, 5 to 6 ,, . .	354½	13·9	380	17·33
,, 6 to 7 ,, . .	178¼	7·0	219	10·0
,, 7 to 8 ,, . .	113	4·4	179½	8·1
,, 8 to 9 ,, . .	57¼	2·2	79¾	3·64
,, 9 to 10 ,, . .	46	1·8	97¾	4·5
,, 10 to 11 ,, . .	6	0·23	13½	0·6
,, 11 to 12 ,, . .	16	0·63	35½	1·6
,, 12 to 13 ,, . .	7¾	0·30	13	0·6
,, 13 to 14 , . .	1½	0·05	12	0·54
,, 14 to 15 ,, . .	1¼	0·05	½	0·02
,, 15 to 16 ,, . .	1½	0·05	1¼	0·06
20 mds. per acre . . .	..	..	3½	0·20
22 ,, ,, . . .	4	0·15	..	..
24 ,, ,, . . .	.	..	⅝	0·05
28 ,, ,, . .	1	0·04	..	..

Effect of soil conditions on yield.—Cotton does not do well in very light soils. American cotton is still more unsuitable for such soils. Soils in Toba Tek Singh and Samundari *tehsils* of the Lyallpur District are light. Very little American cotton is, therefore, grown in these *tehsils*. Prevalent types of soil in the Lyallpur and Jaranwala *tehsils* of this district are light loam and loam. Both *Desi* and American cottons are grown in many villages of these *tehsils**.

A cultivator considers a loam, which tends to be somewhat clayey and retains moisture well, to be a good soil. If a soil is manured it is also considered good for one or two years by a cultivator even after the year in which manure was applied. For practical purposes he generally puts soils in two main classes, *viz.*, rich and poor. In rich soils he generally includes loam tending to be somewhat stiff and soils which were manured during the past one or two years or on which leguminous crops such as berseem (*Trifolium alexandrinum*), *shaftal* (*Trifolium resupinatum*) or *senji* (*Melilotus parviflora*) were grown previously. Light and saltish lands or those lands which were not manured previously, are considered to be poor. Very stiff soils are not commonly met with in this district and wherever they are, they are not generally put under cotton. It was impossible to subject soils of the villages investigated to an actual chemical or physical test. The cultivator was asked whether, according to his own judgment, he considered the soil put under cotton to be rich or poor as described above.

Of the 956 cultivators who were interrogated, 362 stated that the soil in which they had sown American cotton was better than that sown with *Desi* cotton. In 594 cases the soil under both *Desi* and American cottons was considered to be similar. The average yield per acre of *Desi* and American cotton under similar soil conditions is given below :—

Variety of cotton	Area	Total outturn of *kapas* (seed-cotton)	Outturn per acre
	Acres	Mds.	Mds.
Desi	1,039½	4,497½	4·3
American	1,059¾	4,926¼	4·5

It is interesting to note that during the year of enquiry under similar soil conditions, there was practically no difference in the yield of *Desi* and American cottons, that of the former being 4·3 maunds and that of the latter 4·5 maunds per acre.

* The villages studied for this enquiry are situated in these two *tehsils*.

Cultivators generally sow American cotton on good soil. The yield of American cotton under superior and that of *Desi* under inferior soil conditions is set out briefly in the table given below :—

Variety of cotton	Area	Total outturn of *kapas* (seed-cotton)	Outturn per acre
	Acres	Mds.	Mds.
Desi	1,062	5,046¼	4·75
American	939½	5,784½	6·15

Naturally, as the soil for American cotton is superior to that for *Desi*, the yield per acre of American cotton is here higher than that of *Desi* cotton.

Number of irrigations.—The zamindars keep no written record of irrigations given to the crops; but still an effort was made to ascertain from them the number of irrigations given to these two cottons. These figures have not got much absolute value but they are good enough to give a comparative idea of the irrigations applied to *Desi* and American cottons.

The information collected is given in the following table :—

Number of irrigations	*Desi* cotton		American cotton	
	Actual area receiving	Per cent to total area	Actual area receiving	Per cent to total area
1 . .	5¼	0·2	11	0·5
2 . .	94¼	3·7	3½	0·2
3 . .	570¾	*22·35*	97¼	4·4
4 . .	925¾	*36·2*	536½	*24·4*
5 . .	769½	*30·14*	719	*32·7*
6 . .	76	3·0	618	*28·1*
7 . .	70¾	2·8	80¼	3·7
8 . .	34½	1·35	95	4·3
9 . .	1½	0·06	9¾	0·4
10 . .	..	..	16½	0·8
12 . .	5	0·2	11	0·5

The number of irrigations most commonly given to American cotton seems to be four to six and to *Desi* cotton three to five.

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Previous crops.—The various crops which preceded American and *Desi* cottons in the cases investigated are given in the following table :—

Name of the preceding crop	*Desi* cotton		American cotton	
	Actual area	Per cent to the total area	Actual area	Per cent to the total area
	Acres		Acres	
Wheat	1,674¾	*65·5*	800	*36·5*
Toria (*Brassica campestris*) .	246½	9·6	278	12·7
Gram	208½	8·2	173	7·9
Cultivated fallow . . .	306¼	*12·0*	371½	*16·9*
Sugarcane	14¾	0·6	67¼	3·1
Maize and *senji* (*Melilotus parviflora*), *shaftal* (*Trifolium resupinatum*)	50¾	*2·0*	400	18·2
Other fodders—*chari* (*Andropogon Sorghum*), *sarson* (*Brassica campestris*), and turnips, etc.	33¾	1·3	59¾	2·7
Cotton	12¼	0·5	25¾	1·2
Vegetables and condiments (melons, onions, tobacco, etc.)	7¼	0·3	16¼	0·8
	2,555	100·0	2,192	100·0

From the statement given above it would be seen that 65 per cent of the area under *Desi* cotton comes after wheat ; 18 per cent after *toria* (*Brassica campestris*) and gram ; and only 17 per cent after cultivated fallow, sugarcane, maize, *senji* (*Melilotus parviflora*) and vegetables. In the case of American cotton 36·5 per cent of the area follows wheat, 20·5 per cent *toria* (*Brassica campestris*) and gram and 43 per cent follows cultivated fallow, sugarcane, maize, *senji*, fodders and vegetables. It would thus appear that American cotton is given better land than *Desi* cotton.

Manuring.—Farmyard manure is the only manure which is applied generally by the cultivators. On an average a cultivator applies from 10 to 16 cartloads of this manure per acre. Its average composition is given below :—

	Per cent
Moisture	70
Organic matter	4
Nitrogen	0.430
P_2O_5	0.240
K_2O	0.320

The table given below shows separately the percentage of the total area under *Desi* and American cottons manured directly and indirectly :—

Particulars	*Desi* cotton		American cotton	
	Actual area manured	Per cent to total area	Actual area manured	Per cent to total area
	Acres		Acres	
Direct manure (applied to cotton)	552	21·6	796	36·3
Indirect manure (applied to previous crop)	223	8·7	758	34·5
Total area manured . .	775	30·3	1,554	70·8

From the above table, it is quite clear that American cotton receives much more manure, directly as well as indirectly, than *Desi* cotton.

Hoeing and inter-culture.—Educated and intelligent cultivators sow their cotton in lines, but the average uneducated man still sows his cotton by broadcasting. In the villages surveyed, which are inhabited by small cultivators, only a small area was found to be sown in lines. Cotton sown in lines is frequently inter-cultured by hoes drawn by bullocks. Broadcasted cotton is either hand-hoed or inter-ploughed with *Desi* plough once or twice in July and August. The extent of inter-ploughing is shown in the following table :—

Particulars	*Desi* cotton		American cotton	
	Actual area	Per cent to total area	Actual area	Per cent to total area
	Acres		Acres	
No inter-ploughing . .	44¼	1·7	39¼	1·8
Inter-ploughing with *Desi* plough once	2,372½	92·9	1,957	89·3
Inter-ploughing with *Desi* plough twice	138¼	5·4	195¾	8·9
	2,555	100·0	2,192	100·0

These figures show that almost all of the cotton, both *Desi* and American, is hoed with the *Desi* plough; only 1·8 per cent of the cotton area remained without inter-culture.

Hoeing with khurpa *or* kasula. Hand-hoeing with these hand tools is given in some cases in addition to inter-ploughing. It varied from cultivator to cultivator. This practice was more common among farmers cultivating their own lands than among tenants. The extent of hand-hoeing is given in the following table :—

No. of hand-hoeings	*Desi* cotton		American cotton	
	Actual area receiving	Per cent to total area	Actual area receiving	Per cent to total area
	Acres		Acres	
No hoeing	1,287¼	50·4	907¼	41·35
1 hoeing .	795	31·1	774	35·3
2 hoeings .	436½	17·1	437¾	20·0
3 hoeings .	32	1·2	65½	3·0
4 hoeings .	4½	0·2	7¾	0·35

These hoeings were in addition to inter-ploughing. It would be seen that on the whole American cotton received slightly more hand-hoeings.

Summary

(1) In all 64 villages were visited and 953 cultivators interrogated for the purpose of this enquiry.

(2) 2555 acres of *Desi* cotton and 2192 acres of American cotton were dealt with.

(3) The yield of *Desi* cotton varied from 1 to 28 mds. and that of American cotton from 1 to 24 mds. per acre. The average yield per acre was 4·48 mds. for *Desi* cotton and 5·35 mds. for American cotton.

(4) On the whole, American cotton was grown under more favourable conditions with regard to soil, irrigation, manure, etc.

(5) Number of irrigations given to cotton varied from one to twelve. Generally the number of irrigations given to *Desi* and American cottons varied from three to five and four to six respectively.

(6) Sixty-five per cent of the area under *Desi* cotton was sown after wheat 18 per cent after *toria* (*Brassica campestris*), gram and cotton ; and 17 per cent after cultivated fallow, sugarcane, maize, *senji* (*Melilotus parviflora*) and vegetables. The extent of previous cropping in the case of American cotton was :

	Per cent
Wheat	36·5
Toria (*Brassica campestris*) and gram	20·5
Cultivated fallow, sugarcane, maize, *senji* (*Melilotus parviflora*), vegetables, etc.	43·0

(7) 21·6 per cent of the area under *Desi* cotton was manured directly and 8·7 per cent indirectly. In the case of American cotton 36·3 per cent of the area was manured directly and 34·5 per cent indirectly.

CAUSES OF FLUCTUATION OF AREA UNDER COTTON IN THE CANAL COLONIES OF THE PUNJAB

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Introduction

The area under cotton in the Punjab shows a great variation from year to year. There may be as much as 51 per cent variation between two consecutive years as in 1914-15 and 1915-16. The area under cotton during 1914-15 was 1,687,763 acres but it fell to 826,504 acres during the following year. The study of the factors which bring about such a large variation is interesting, from the commercial as well as the agricultural point of view.

Object.—This enquiry was undertaken to study the causes responsible for the fluctuation of the area under cotton in the Punjab.

Scope of the enquiry. The enquiry was confined to the tracts irrigated by the main canals only. for most of the cotton in the Punjab is grown in these tracts. The tracts irrigated by the following canals were included in this enquiry :—

1. Lower Chenab.
2. Upper Chenab.
3. Lower Bari Doab.
4. Upper Bari Doab.
5. Lower Jhelum
6. Upper Jhelum.

Sources of data.—The data have been collected from the following sources :—

(1) Annual Reports of the Punjab Irrigation Department.

(2) Season and Crop Reports of the Punjab Agricultural Department.

(3) *Lal Kitabs** of the Punjab Revenue Department.

The figures of area under different crops were taken from the Annual Reports of the Punjab Irrigation Department, for all the years studied. The figures for prices and outturns were given in the Reports of the Irrigation Department only

* *Lal Kitab* is a book maintained by the village accountant (*Patwari*) which contains agricultural statistics.

from 1921-22 onwards, so the figures relating to the period prior to that year (1921-22) have been taken from the Season and Crop Reports. But in the Season and Crop Reports these figures are given by districts. The average of the districts comprising the tract has, therefore, been taken as the average of the tract irrigated by a canal.

Figures for the area under cotton and sugarcane in a number of villages in the Lyallpur District, in which sugarcane is an important crop, were taken from the *Lal Kitabs.*

Factors causing fluctuations in area.—Below are given the factors which can possibly affect the area under cotton :—

(1) Market price of cotton during the previous year

(2) Condition of previous year's cotton crop or yield per acre in the previous year.

(3) Area under other competing crops such as sugarcane and maize.

(4) Supply of canal water at sowing time.

The effect of each factor is discussed separately below :—

1. Price of cotton during the previous year

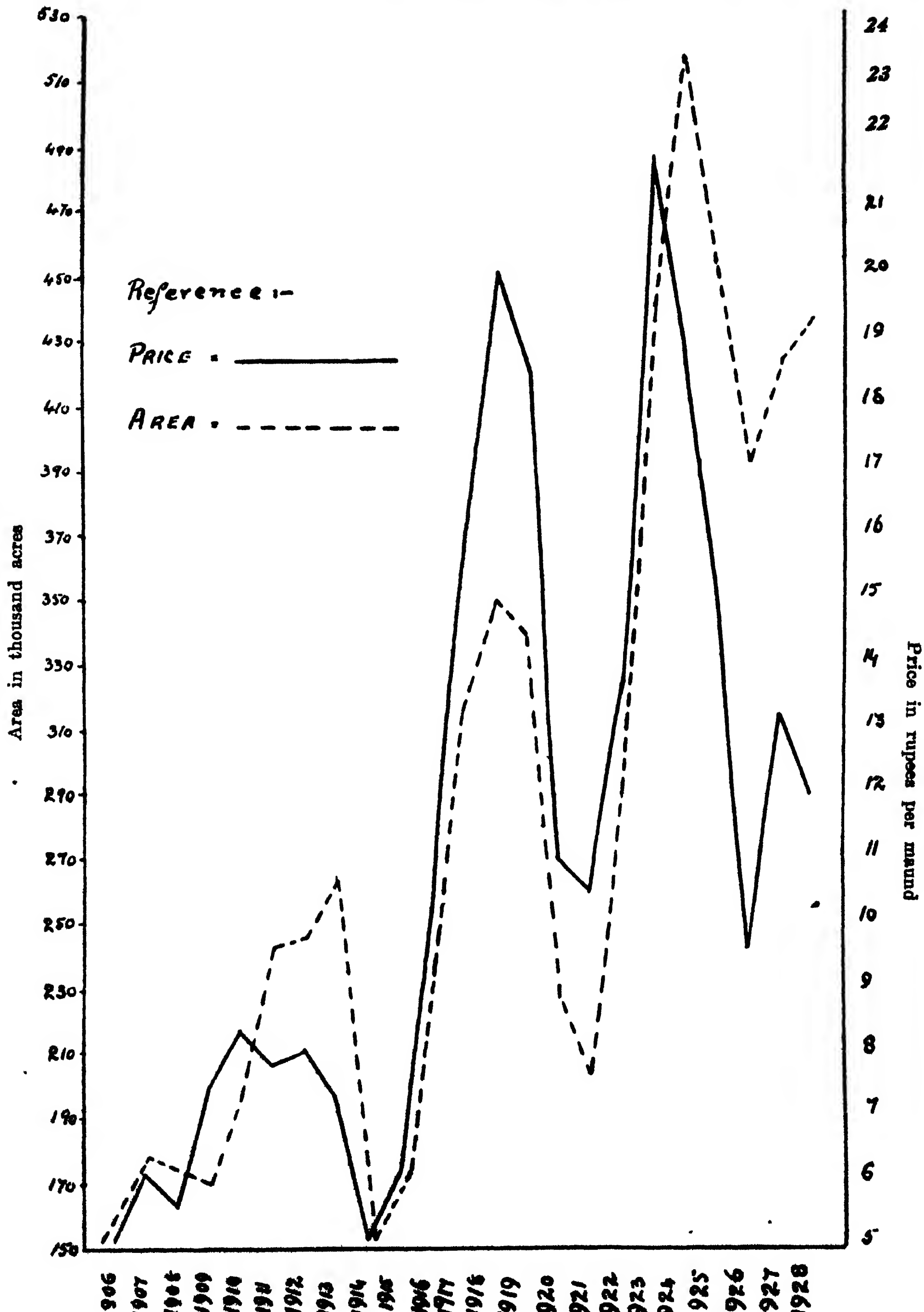
The prices of agricultural produce should naturally affect the choice of the cultivator in the preparation of his cropping scheme. In the present case, area under cotton and cotton prices during the previous year were studied statistically. The co-efficients of correlation between these two variables were calculated for various tracts and are given in the following table :—

Showing co-efficients of correlation between price of cotton in the previous year and area under cotton in the following year

Serial No.	Name of the tract	Co efficients of correlation
1	Lower Chenab	+ ·81 ± ·048
2	Upper Chenab	+ ·83 ± ·050
3	Lower Bari Doab	+ ·78 ± ·066
4	Upper Bari Doab	+ ·83 ± ·044
5	Lower Jhelum	+ ·60 ± ·089
6	Upper Jhelum	+ ·40 ± ·150

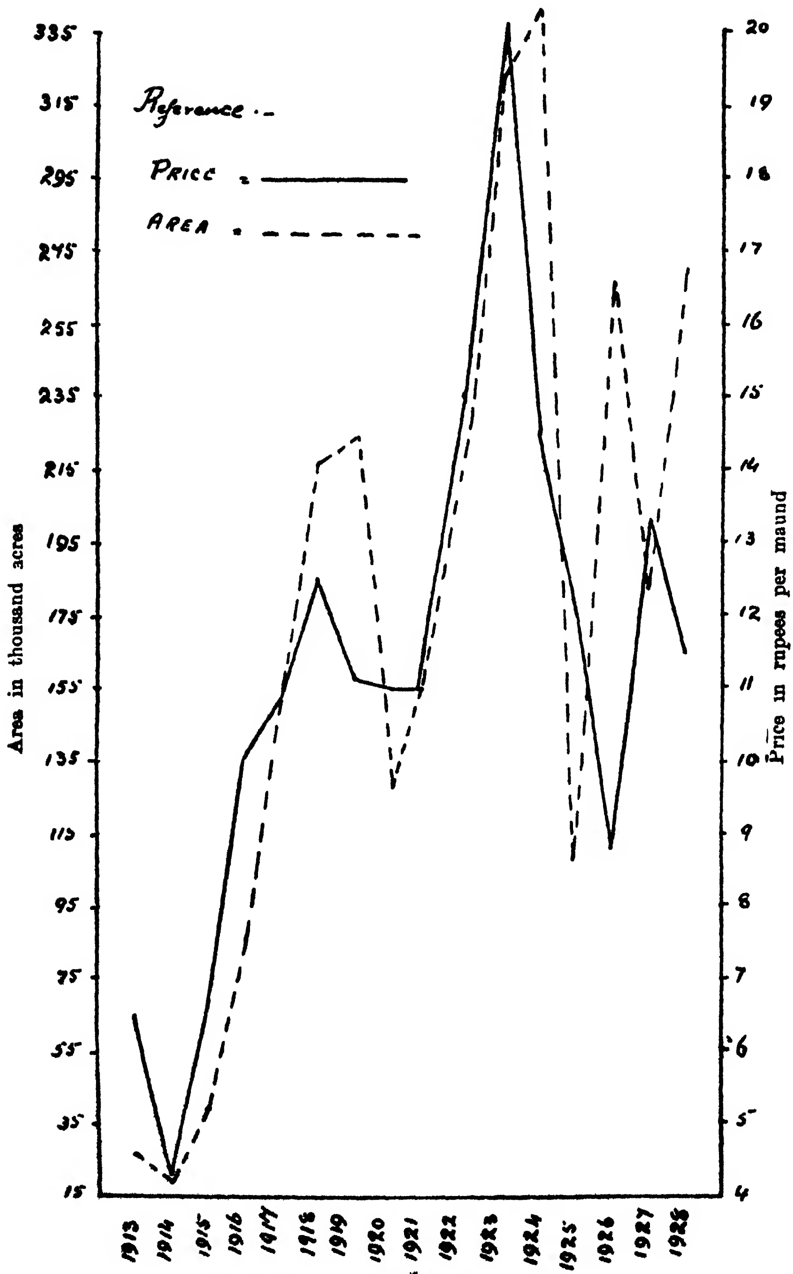
Judged by the tests of significance, all these co-efficients of correlation are highly significant. The co-efficients of correlation are quite high for all the canals, excepting Lower Jhelum and Upper Jhelum Canals, which means that either the cultivators on these canals are not very progressive, or other conditions are not favourable for increasing the area under other alternative crops. Such a high degree of positive correlation shows that high prices of cotton are followed largely by an increase in the area under cotton during the following year.

The relation between the area under cotton and cotton prices during the previous year has been represented graphically in synchronised Graphs 1 and 2 for the two principal canals, *viz.*, Lower Chenab Canal and Lower Bari Doab Canal. It would be seen from these graphs that both the area and the prices curves run fairly in the same direction.



GRAPH 1

Showing effect of price of cotton on the area under cotton in Lower Chenab Canal



GRAPH 2

Showing effect of price of cotton on the area under cotton in the Lower Bari Doab Canal Colony

2. Condition of the previous year's cotton crop as judged by the yield per acre

It is quite natural that the condition of a crop, in other words, the yield per acre obtained during a particular year should affect the area under that crop during the following year. The extent of the effect of this factor has been calculated mathematically and given in the following table for the American cotton alone and for both "*Desi*" and American cottons together :—

Showing co-efficients of correlation between yield per acre in the previous year and area under cotton in the following year.

Serial No.	Name of the tract	Area under cotton (*Desi* and American)	Percentage area under American cotton	Co-efficients of correlation	
				Both *Desi* and American cottons	American cotton only
		(Average for the whole period)			
1	Lower Chenab .	276,390	67·3	+·20±·13	+·84±·07
2	Upper Chenab .	30,662	50·9	+·60±·10	+·67±·13
3	Lower Bari Doab .	162,972	82·6	+·03±·16	+·57±·16
4	Upper Bari Doab .	179,729	2·9	+·30±·12	+·61±·15
5	Lower Jhelum .	88,806	82·7	+·15±·13	+·47±·19
6	Upper Jhelum .	45,539	91·9	+·04±·21	+·14±·24

The co-efficients of correlation, though all positive, are small except in the case of Upper Chenab Canal which has got comparatively only a small area under cotton. The yield per acre, therefore, taking both *Desi* and American cottons together, does not seem to influence the area under this crop in the following year. On the other hand, the area under the American cotton is influenced considerably by the yield of this crop during the previous year, as shown by the co-efficients of correlation which are fairly high and positive. The co-efficient of correlation is highest for the Lower Chenab Canal where both *Desi* and American cottons are often grown side by side by the same cultivator. So here, a decrease in area under American cotton is followed by an increase in area under *Desi* cotton. On the Upper Jhelum Canal, American cotton occupies 92 per cent of the area under

cotton and here the yield per acre affects the area under American cotton least of all as shown by the low co-efficient of correlation ($r = + \cdot 14 \pm \cdot 24$).

N. B.—It may be noted that the figures for yields per acre are not actual yields but are the results of estimates made by the Irrigation and Revenue staff. If actual yields had been available, the effect of this factor would have been shown more clearly.

3. Area under other competing crops

Sugarcane and maize are the main crops which compete with cotton. One would, therefore, naturally think that if the area under competing crops increases the area under cotton should decrease and *vice versa*. The effect of both these competing crops has been studied separately.

Sugarcane.—To study quantitatively the effect of the area under cane on the area under cotton, co-efficients of correlation between the areas under these two crops have been calculated for all the tracts under study and are given in the following table :—

Showing the co-efficients of correlation between area under sugarcane and area under cotton.

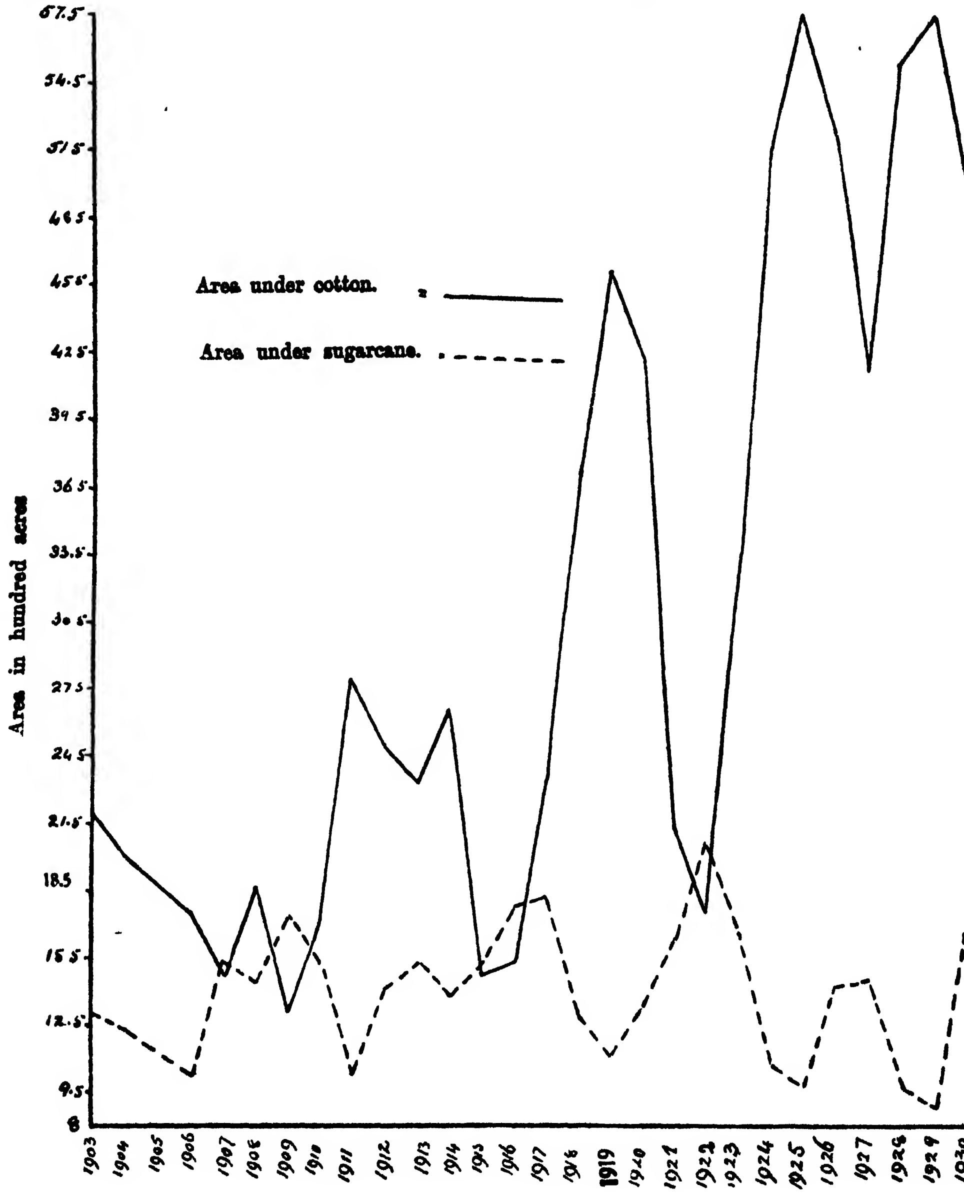
Serial No.	Name of the tract	Area under sugarcane (average for the whole period)	Percentage of area under cane to that under cotton	Co-efficients of correlation
1	Lower Chenab	52,930	19·1	$+0·16 \pm 0·135$
2	Upper Chenab	6,891	22·4	$+0·36 \pm 0\ 14$
3	Lower Bari Doab	7,207	4·4	$+0\ 19 \pm 0·168$
4	Upper Bari Doab	33,056	18 4	$+0\ 06 \pm 0·14$
5	Lower Jhelum	6,388	7·2	$+0·02 \pm 0·14$
6	Upper Jhelum	5,026	11 03	$-0\ 19 \pm 0·18$

The above table does not lead us to any definite conclusion about the relationship between the area under sugarcane and that under cotton. The errors of sampling are too high.

To remove this difficulty and to study further the effect of this factor more thoroughly sixteen villages in the Lyallpur District in which cane and cotton are grown by the same cultivator were sampled and statistical study was continued. The data relating to the acreage under sugarcane and cotton are given in Table V.

The co-efficient of correlation between the area under cotton and that under sugarcane was found to be $-0·56 \pm 0·087$. Here it is clearly shown that an increase in area under sugarcane brings about a decrease in the area under cotton

and *vice versa*. This relation is further illustrated in Graph 3. In this graph the peaks of one curve are exactly against the depressions of the other.



GRAPH 3

Showing effect of area under sugarcane on that under cotton in 16 villages in the Lyallpur District

Maize.—This crop also grows during the summer season and competes with cotton. The effect of area under this crop on the area under cotton was calculated quantitatively and is given in the following table :—

Showing co-efficients of correlation between area under maize and area under cotton.

Serial No.	Name of the tract	Area under maize in acres (average for the whole period)	Percentage of area under maize to area under cotton	Co-efficients of correlation
1	Lower Chenab	92,538	33·4	—·51±·10
2	Upper Chenab	5,126	16·7	—·22±·15
3	Lower Bari Doab	27,617	16·9	+·21±·16
4	Upper Bari Doab	60,522	33·7	—·81±·47
5	Lower Jhelum	16,672	18·7	+·15±·15
6	Upper Jhelum	4,724	10·3	—·07±·18

As was expected co-efficients of correlation are negative with the exception of Lower Bari Doab and Lower Jhelum Canals. It means that generally the area under maize adversely affects the area under cotton.

N. B.—It may be noted that the relative prices of competing crops are of obvious importance but the study did not extend to these factors.

4. Supply of canal water at sowing time

Usually there is enough water in the perennial canals of the Punjab during April and May when cotton is sown. The area under cotton is, therefore, determined generally by the other factors already discussed. But in certain years as in 1914-15, 1920-21 and 1921-22, canal water supply at the sowing time became a limiting factor. As no quantitative data regarding water-supply during the sowing time could be obtained, the effect of this factor could not be studied statistically. The instances given above are based on the statements, made by the Director of Land Records in the Season and Crop Reports, regarding water-supply at sowing time of cotton.

5. Summary of chief findings

(1) The area under cotton in the canal-irrigated tracts varies considerably from year to year. There may be as much as 90 per cent variation between two consecutive years as in 1914-15 and 1915-16 in case of Lower Jhelum Canal Colony.

(2) The main factor responsible for this variation is the price of cotton during the previous year. The co-efficients of correlation between these two variables have been worked out and are given on page 713.

(3) The correlation between the yield per acre during the previous year and the area under cotton, when both *Desi* and American cottons are taken together, is insignificant. If, however, the American cotton alone be taken into consideration, it has been found that a low yield per acre is followed by a decreased area under this crop. The effect of this factor has been studied statistically.

(4) The area under sugarcane does not seem to affect the area under cotton when we take the whole tract into consideration. However, if we take only those villages into account (as in Lyallpur District) where sugarcane and cotton are grown by the same cultivator, it is clearly shown that an increase in area under sugarcane brings about a decrease in area under cotton and *vice versa*.

(5) There is usually enough water in the Punjab canals at the sowing time of cotton but in some years such as 1914-15, 1920-21 and 1921-22 scarcity of canal-water also becomes a limiting factor with regard to the area under cotton.

TABLE I

Showing area under cotton (Desi and American) in acres in the main canal-irrigated tracts.

Year	Lower Chenab Canal			Upper Chenab Canal			Lower Bari Doab Canal			Upper Bari Doab Canal			Lower Jhelum Canal			Upper Jhelum Canal		
	Desi	American	Total	*Desi*	American	Total	*Desi*	American	Total	*Desi*	American	Total	*Desi*	American	Total	*Desi*	American	Total
1906-7	...	...	90,438	..	...	...		.	.		.	61,911	.	..	57,524	...	...	.
1907-8	...	...	152,0.8	...					.	.	.	108,028	...	...	44,925	...	..	..
1908-9	...	...	178,096	...	...							175,250	...	..	30,112	..	...	
1909-10	...	...	148,815	...	...	...	..	..	..		..	91,204	.	..	56,307	..	...	...
1910-11	...	...	170,329	...	...	...	...	...	.		..	113,297	...		68,318	...	...	...
1911-12	...	...	197,053	.	...	...		.	..	.	.	155,303	...	..	48,518	..	...	.
1912-13	..	...	242,178	...	...	1,706	...	..	.		..	186,813	.	...	91,491	.	.	...
1913-14	.	...	246,171	...	...	12,149	..	..	297	...	.	224,989		..	105,168	..	...	...
1914-15	...	...	261,819	...	..	14,868	...	..	26,938	.	..	180,565	..	...	94,707			...
1915-16	...	...	153,471	...	...	3,422	.	.	18,953			88,790	...	..	11,371	.	..	...
1916-17	...	...	173,467	...	...	20,883	...	...	39,652	..		147,021	...	..	51,641	.	...	2,307
1917-18	...	...	235,521	...	...	...	.		86,356	...	..	...	...	.	76,301	.	...	20,264
1918-19	...	...	315,067	..	...	18,818	..	...	152,115	.		137,064	...	...	89,942	...	..	22,888
1919-20	...	...	340,251	...	...	44,354	...		217,137	..	...	233,073	...	..	112,906	...	...	39,693
1920-21	...	...	339,296	..	...	38,859	...	..	223,943	...	...	210,043	...	..	107,233	...	...	43,760
1921-22	68,074	160,848	226,922	19,516	6,468	25,984	7,437	120,601	1 8,026	131,752	4,952	136,704	12,956	62,792	75,748	9,433	42,060	51,483
1922-23	108,810	93,428	203,238	16,298	9,311	25,609	19,800	135,657	155,457	178,049	770	178,819	34,275	30,278	64,553	7,946	25,245	33,191
1923-24	85,101	204,425	289,526	20,491	11,749	32,240	19,743	209,723	229,466	208,745	2,123	210,868	20,670	72,550	93,220	4,247	33,770	38,017
1924-25	103,317	336,800	440,117	26,070	24,664	50,734	17,054	306,34-	223,402	252,768	5,747	258,515	15,061	132,079	147,140	3,311	57,848	61,159
1925-26	126,331	389,781	516,112	23,464	51,599	75,063	27,722	314,329	342.051	292,619	14,696	307,315	11,938	168,403	180,341	3,939	78,306	82,245
1926-27	117,977	335,394	453,371	22,167	21,827	43,994	41,707	66,145	107,852	188,325	6,471	194,866	12,881	100,211	113,092	3,257	46,20-	49,464
1927-28	139,374	252,713	392,087	14,324	24,613	38,937	64,016	201,994	266,010	196,022	7,397	203,419	20,123	130,032	150,155	2,290	48,535	50,825
1928-29	162,201	260,766	422,967	20,232	21,882	42,114	61,559	121,883	183,442	271,066	11,841	282,907	29,167	159,044	188,211	3,519	71,264	74,783
1929-30	200,074	236,041	436,115	17,239	13,988	31,227	88,436	181,332	269,768	241,791	5,106	346,89 7	29,820	42,296	72,116	3,278	64,174	67,453

Note :—(1) Classification of area under cotton into *Desi* and American cottons was started by the revenue authorities only from 1921-22 onward, so separate figures for area under American cotton before 1921-22 cannot be had.

(2) Upper Chenab Canal was opened in 1912-13, Lower Bari Doab Canal in 1913-14, and Upper Jhelum Canal was opened in 1915-16.

TABLE II.

Prices of **kapas** *(seed-cotton) in rupees per maund (82 lbs.) in the main canal-irrigated tracts*

Year	Lower Chenab Canal		Upper Chenab Canal		Lower Bari Doab Canal		Upper Bari Doab Canal		Lower Jhelum Canal		Upper Jhelum Canal	
	Desi	American	*Desi*	American	*Desi*	American	*Desi*	American	*Desi*	American	*Desi*	American
1906-07	5·1	..	..	..	..	..	5·3	..	5·8	..	..	..
1907-08	6·1	..	..	..	..	..	5·4	..	6·7	..	..	..
1908-09	5·6	..	..	..	..	..	5·0	..	5·7	..	..	..
1909-10	7·4	..	..	..	..	..	5·7	..	7·3	..	..	..
1910-11	8·3	..	..	..	..	..	7·7	..	10·0	..	..	..
1911-12	7·8	..	..	..	..	..	7·0	..	8·0	..	..	..
1912-13	8·0	..	7·5	..	..	..	7·3	..	7·6		..	..
1913-14	7·3	..	6·5	..	6·5	..	6·3	..	6·7	..	..	..
1914-15	5·1	..	3·8	..	4·3	..	4·0	..	4·0	..	..	..
1915-16	6·1	..	6·0	..	6·6	..	5·8	..	6·2	..	..	..
1916-17	10·2	..	8·0	..	10·0	..	8·3	..	8·5	..	..	..
1917-18	16·1	..	..	..	11·0	..	..	..	16·0	..	..	..
1918-19	20·0	..	13·3	..	12·5	..	14·0	..	16·0	..	13·3	..
1919-20	18·5	..	13·3	..	11·1	..	13·3	..	16·0	..	11·0	..
1920-21	11·0	..	8·6	..	10·0	..	8·3	..	10·0	..	8·0	..
1921-22	10·5	..	11·4	..	10·0	..	9·5	..	10·0	13·0	13·0	..
1922-23	11·9	15·5	11·8	16·2	12·9	17·2	10·1	17·2	12·9	16·6	10·0	17·7
1923-24	19·6	24·1	16·3	22·1	17·6	22·1	17·8	17·8	16·1	18·8	16·8	22·7
1924-25	18·0	19·4	13·4	16·7	13·1	15·8	12·9	16·0	14·0	15·8	11·4	13·3
1925-26	13·9	15·9	9·9	11·9	11·0	13·2	10·2	12·5	10·1	12·4	9·0	12·9
1926-27	9·0	10·2	8·1	8·8	8·9	8·7	8·0	10·5	7·7	8·7	9·0	10·0
1927-28	12·0	14·4	11·2	13·3	12·7	13·8	11·8	14·0	11·8	13·9	10·0	13·0
1928-29	10·9	13·0	10·0	13·1	10·2	12·9	9·3	13·0	12·7	14·2	10·0	13·0
1929-30	6·7	10·5	6·9	8·2	5·2	9·1	6·7	8·0	6·5	8·3	8·0	10·0

TABLE I

Showing area under cotton (Desi *and* American) *in acres in the main canal-irrigated tracts.*

Year	Lower Chenab Canal			Upper Chenab Canal			Lower Bari Doab Canal			Upper Bari Doab Canal			Lower Jhelum Canal			Upper Jhelum Canal		
	Desi	American	Total	*Desi*	American	Total	*Desi*	American	Total	*Desi*	American	Total	*Desi*	American	Total	*Desi*	American	Total
1906-7	...	...	90,438	...	...	...		...	...		...	61,911	...	...	57,524	...	...	...
1907-8	...	...	152,0.8	...			...		...	...	...	108,026	...	...	44,925	...	...	...
1908-9	...	...	178,096	...	...							175,250	...	...	30,112	...	...	...
1909-10	...	...	148,815	...	...	...	...	...	...		...	91,204	...	...	56,307	...	...	...
1910-11	...	...	173,729	...	...	...	...	...	...	...	...	113,267	...		68,318	...	...	...
1911-12	...	...	197,058	...	...	...		...	...	...	...	155,302	...	...	48,818	...	...	...
1912-13	...	...	242,178	...	...	1,706	...	...	...		...	186,813	...	...	91,491	...	...	...
1913-14	...	...	246,171	...	...	12,149	...	...	297	...	...	324,989		...	105,168	...	...	...
1914-15	...	...	261,819	...	...	14,868	...	...	26,988		...	150,565	...	...	94,707			...
1915-16	...	...	153,471	...	...	3,422	...	...	18,953			88,790	...	...	11,371	...	...	...
1916-17	...	...	173,467	...	...	20,863	...	...	39,662	...		147,031	...	...	51,641	...	...	2,307
1917-18	...	...	236,521	...	...	...	...	...	66,356	...	...	...	...	...	76,301	...	...	20,204
1918-19	...	...	315,067	...	...	18,818	...	...	152,105	...		137,064	...	...	89,942	...	...	22,868
1919-20	...	...	349,251	...	...	44,354	...		217,137	...	...	233,073	...	...	112,906	...	...	39,693
1920-21	...	...	339,296	...	...	38,859	...	...	223,943	...	...	210,643	...	...	107,233	...	...	43,780
1921-22	66,074	160,848	226,922	19,516	6,468	25,984	7,437	120,601	178,038	131,752	4,952	136,704	12,956	62,792	75,748	9,433	42,060	51,463
1922-23	108,810	99,428	208,238	16,298	9,311	25,609	19,800	135,657	155,457	178,049	770	178,819	34,275	30,278	64,553	7,946	25,245	33,191
1923-24	85,101	204,425	289,526	20,491	11,749	32,240	19,743	209,723	229,466	208,745	2,123	210,868	20,670	72,550	93,220	4,247	33,770	38,017
1924-25	103,317	336,800	440,117	26,070	24,664	50,734	17,054	306,348	323,402	252,768	5,747	258,515	15,061	132,059	147,140	3,311	57,848	61,159
1925-26	126,331	389,781	516,112	23,464	51,899	75,363	27,722	314,329	342,051	292,619	14,696	307,315	11,938	168,403	180,341	3,939	78,306	82,245
1926-27	117,977	335,394	453,371	22,167	21,827	43,994	41,707	66,145	107,852	188,395	6,471	194,866	12,881	100,211	113,092	3,257	46,207	49,464
1927-28	139,374	352,713	392,087	14,324	24,613	38,937	64,016	201,994	266,010	196,022	7,397	203,419	20,123	130,032	150,155	2,290	48,535	50,825
1928-29	162,201	260,766	422,967	20,282	21,832	42,114	61,559	121,883	183,442	271,066	11,841	282,907	29,167	159,044	188,211	3,519	71,264	74,783
1929-30	200,074	236,041	436,115	17,239	13,988	31,227	88,436	161,332	269,768	241,791	5,106	246,897	29,820	42,296	72,116	3,278	64,174	67,452

Note :—(1) Classification of area under cotton into *Desi* and American cottons was started by the revenue authorities only from 1921-22 onward, so separate figures for area under American cotton before 1921-22 cannot be had.

(2) Upper Chenab Canal was opened in 1912-13, Lower Bari Doab Canal in 1913-14, and Upper Jhelum Canal was opened in 1915-16.

TABLE II.

Prices of **kapas** *(seed-cotton) in rupees per maund (82 lbs.) in the main canal-irrigated tracts*

Year	Lower Chenab Canal		Upper Chenab Canal		Lower Bari Doab Canal		Upper Bari Doab Canal		Lower Jhelum Canal		Upper Jhelum Canal	
	Desi	American	*Desi*	American	*Desi*	American	*Desi*	American	*Desi*	American	*Desi*	American
1906-07	5·1	..	..	..	..	..	5·3	..	5·8	..	..	..
1907-08	6·1	..	..	.	..	..	5·4	..	6·7	..	..	..
1908-09	5·6	..	..	..	..	..	5·0	..	5·7	..	..	..
1909-10	7·4	..	..	..	..	..	5·7	..	7·3	..	..	..
1910-11	8·3	..	..	..	..	..	7·7	..	10·0	..	..	..
1911-12	7·8	..	..	..	..	..	7·0	..	8·0		..	..
1912-13	8·0	..	7·5	..	..	..	7·3	..	7·6	..	..	..
1913-14	7·3	..	6·5	..	6·5	..	6·3	..	6·7	..	..	..
1914-15	5·1	..	3·8	..	4·3	..	4·0	..	4·0	..	..	..
1915-16	6·1	..	6·0	..	6·6	..	5·8	..	6·2	..	..	..
1916-17	10·2	..	8·0	..	10·0	..	8·3	..	8·5	..	..	..
1917-18	16·1	..	..	..	11·0	..	..	..	16·0	..	..	..
1918-19	20·0	..	13·3	..	12·5	..	14·0	..	16·0	..	13·3	..
1919-20	18·5	..	13·3	..	11·1	..	13·3	..	16·0	..	11·0	..
1920-21	11·0	..	8·6	..	10·0	..	8·3	..	10·0	..	8·0	..
1921-22	10·5	.	11·4	..	10·0	..	9·5	..	10·0	13·0	13·0	..
1922-23	11·9	15·5	11·8	16·2	12·9	17·2	10·1	17·2	12·9	16·6	10·0	17·7
1923-24	19·6	24·1	16·3	22·1	17·6	22·1	17·8	17·8	16·1	18·8	16·8	22·7
1924-25	18·0	19·4	13·4	16·7	13·1	15·8	12·9	16·0	14·0	15·8	11·4	13·3
1925-26	13·9	15·9	9·9	11·9	11·0	13·2	10·2	12·5	10·1	12·4	9·0	12·9
1926-27	9·0	10·2	8·1	8·8	8·9	8·7	8·0	10·5	7·7	8·7	9·0	10·0
1927-28	12·0	14·4	11·2	13·3	12·7	13·8	11·8	14·0	11·8	13·9	10·0	13·0
1928-29	10·9	13·0	10·0	13·1	10·2	12·9	9·3	13·0	12·7	14·2	10·0	13·0
1929-30	6·7	10·5	6·9	8·2	5·2	9·1	6·7	8·0	6·5	8·3	8·0	10·0

TABLE III

Showing outturn of **kapas** *(seed-cotton), in lbs. per acre, in the main canal-irrigated tracts*

Year	Lower Chenab Canal		Upper Chenab Canal		Lower Bari Doab Canal		Upper Bari Doab Canal		Lower Jhelum Canal		Upper Jhelum Canal	
	Desi	American	*Desi*	American	*Desi*	American	*Desi*	American	*Desi*	American	*Desi*	American
1906-07	128	..	..	..	..	..	430	..	298	..	..	..
1907-08	469	..	..	..	..	..	500	..	363	..	..	..
1908-09	345	..	..	..	..	..	475	..	363	..	..	..
1909-10	490	..	..	..	..	..	475	..	363	..	..	..
1910-11	487	..	..	..	..	..	475	..	363	..	..	..
1911-12	213	..	..	..	..	..	500	..	121	..	..	..
1912-13	524	..	510	..	..	..	575	..	507	..	..	..
1913-14	710	..	340	..	523	..	500	..	443	..	..	..
1914-15	407	..	306	..	426	..	525	..	403	..	..	..
1915-16	278	..	204	..	373		525	..	121	..	..	..
1916-17	571	..	323	..	505	..	525	..	340	..	..	..
1917-18	455			Not available					280	..	..	..
1918-19	477	..	340	..	275	..	275	..	340	..	552	..
1919-20	492	..	340	..	525	..	525	..	220	..	408	..
1920-21	356	..	391	..	425	..	425	..	340	..	504	..
1921-22	288	..	323	..	400	..	400	..	240	..	336	..
1922-23	303·4	393·6	246	410	516·6	410	393·6	328	344·4	442·8	451	574
1923-24	459·2	500·2	319·8	541·2	533	533	369	344·4	459·2	500·2	401 8	426·4
1924-25	598·6	574	483·8	598·6	451	492	500·2	574	336·2	459·2	410	582·2
1925-26	475·6	459·2	360·8	426·4	393·6	410	434·6	467·4	319·8	352·6	410	475·6
1926-27	360·8	303·4	246	262·4	303·4	270·6	188·6	180·4	262·4	196·8	287	213·2
1927-28	328	410	401·8	418·2	303·4	295·2	385·4	393·6	393·6	451	410	541·2
1928 29	287	278·8	254·2	278·8	213·2	254·2	303·4	278·8	229 6	229·6	311·6	311·6
1929-30	483·8	475·6	188·6	442·8	319·8	459·2	483·8	319·8	328	418·2	410	475·6

TABLE IV

Showing area under sugarcane and maize (in acres) in the main canal-irrigated tracts

Year	Lower Chenab Canal		Upper Chenab Canal		Lower Bari Doab Canal		Upper Bari Doab Canal		Lower Jhelum Canal		Upper Jhelum Canal	
	Sugar-cane	Maize	Sugar-cane	Maize	Sugar-cane	Maize	Sugar-cane	Maize	Sugar-cane	Maize	Sugar-cane	Maize
1906-07	24,575	119,772	..	..	..	..	15,814	86,285	2,723	15,536	..	..
1907-08	45,833	92,093	..	..	..	..	22,224	80,633	5,565	8,530	..	..
1908-09	41,217	85,245	..	..	..	..	29,263	70,050	6,289	12,916	..	..
1909-10	53,441	106,768	..	..	..	..	36,361	69,837	6,686	15,186	..	..
1910-11	44,778	92,982	..	..	..	..	36,633	65,876	6,086	14,219	..	..
1911-12	18,518	81,025	..	..	..	..	19,540	61,189	1,846	14,055	..	..
1912-13	37,640	80,029	1,349	3,395	..	..	27,547	62,167	3,010	14,292	..	..
1913-14	53,772	79,799	2,001	2,906	6	4,729	31,557	53,455	5,283	12,064	..	..
1914-15	44,914	84,390	1,897	3,802	72	9,008	28,963	48,689	5,228	13,393	..	..
1915 16	50,885	108,276	3,096	8,764	481	18,158	29,361	86,517	5,061	21,420	..	..
1916-17	69,149	107,082	7,695	7,001	1,327	19,584	42,465	74,569	8,673	17,480	291	2,573
1917-18	Figures not available											
1918-19	59,443	103,197	6,468	7,014	5,777	31,118	51,679	68,872	5,839	21,582	5,353	9,031
1919-20	50,979	100,071	9,573	6,033	4,327	37,097	53,654	66,481	5,201	17,619	8,589	3,318
1920 21	56,246	80,559	11,702	6,191	4,679	36,960	47,059	55,580	6,708	15,279	7,197	2,791
1921-22	69,532	105,174	9,473	5,976	10,742	42,774	35,577	73,788	9,136	17,257	4,153	2,583
1922-23	97,437	96,368	11,393	4,721	20,285	38,941	41,070	65,069	13,905	18,749	5,433	3,614
1923-24	74,648	92,019	10,687	4,621	10,448	32,227	33,894	47,821	8,511	20,001	6,514	3,751
1924-25	47,921	81,273	7,088	4,324	5,975	28,959	27,795	37,460	4,777	17,890	4,148	4,078
1925-26	42,792	74,006	6,342	3,476	6,678	21,601	28,576	32,631	5,298	13,244	4,115	4,487
1926-27	59,036	75,722	6,823	3,446	11,732	21,612	32,233	35,362	6,290	15,033	4,163	5,561
1927-28	70,002	98,943	7,432	5,174	16 659	34,101	41,403	58,351	12,450	25,870	5,302	8,184
1928-29	55,137	90,858	7,382	5,479	9,627	38,363	30,487	41,857	7,188	20,241	5,330	6,583
1929-30	49,487	92,717	6,758	4,826	6,494	26,643	17,137	49,468	7,167	21,754	4,748	4,857

TABLE V

Showing area under cotton and sugarcane in 16 villages in the Lyallpur District

Year	Total area under cotton in all the 16 villages studied	Average area per village	Total area under sugar-cane in all the villages	Average area under sugar-cane per village
	Acres	Acres	Acres	Acres
1903 . . .	2,177	136	1,287	80
1904 . . .	2,012	126	1,225	77
1906 . . .	1,747	109	1,017	64
1907 . . .	1,470	92	1,501	94
1908 . . .	1,847	115	1,448	91
1909 . . .	1,313	82	1,729	108
1910 . . .	1,708	107	1,524	95
1911 . . .	2,771	173	1,021	64
1912 . . .	2,486	155	1,407	88
1913 . . .	2,325	145	1,524	95
1914 . . .	2,641	165	1,380	86
1915 . . .	1,463	91	1,526	95
1916 . . .	1,529	96	1,758	110
1917 . . .	2,324	145	1,814	113
1918 . . .	3,700	231	1,292	81
1919 . . .	4,581	286	1,112	70
1920 . .	4,206	263	1,310	82
1921 . . .	2,110	132	1,613	101
1922 . . .	1,751	109	2,047	128
1923 . . .	3,340	209	1,662	104

Year	Total area under cotton in all the 16 villages studied	Average area per village	Total area under sugar-cane in all the villages	Average area under sugar-cane per village
	Acres	Acres	Acres	Acres
1924 . . .	5,115	320	1,060	66
1925 . . .	5,703	356	959	60
1926 . . .	5,203	325	1,405	88
1927 . . .	4,139	259	1,430	89
1928 . . .	5,466	342	961	60
1929 . . .	5,696	356	871	54
1930 . . .	4,963	310	1,630	102

SERIAL EXPERIMENTS*

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It is indeed a matter of great satisfaction to find that the conduct of field-experiments on modern systems of lay-out is a subject which has now attracted the attention of most of the agricultural workers in this country. Modern designs of field-experimentations based on the recommendations of Fisher, etc., are hardly a decade old, and their wide application to cultural, varietal, manurial and other experiments is sufficient testimony of their comparative reliability. A field-experimentalist has to derive his results in the face of such odds, as errors due to soil heterogeneity, errors of weighing and measurements, errors brought about by irregular sowings and defective germination, errors brought about by the incidence of diseases and pests and many others. Fisher's analysis of variance has provided a method of interpreting field results and gives a value of the residual error of the experiment after eliminating errors due to soil heterogeneity, varieties, treatments, etc. Nevertheless, the conclusions drawn from any one such experiment are strictly true for the particular soil and climatic conditions under which the experiment has been conducted.

The object of most varietal or manurial trials is to determine which particular treatment is the best for the special conditions of the locality or climate under which the experiment has been conducted. With this aim most experiments are laid out and their results often provide material for basing recommendations for any improved variety or manurial treatment. It is, however, not very safe to base recommendations on the results obtained from a single experiment conducted for a single season. It is quite possible that the same treatments may respond differentially when subjected to varying soil and seasonal conditions. In order to determine whether the behaviour of different varieties or treatments holds good under average conditions, we should invariably base our conclusions on the accumulated data obtained from a series of years, at least three years or more, and if possible, covering different sets of soil and climatic conditions. Such a trial is usually called a serial trial, and as the method of combining results of such serial trials is not generally known in this country, an attempt has been made in this paper to indicate the principles involved.

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All field-experiments must be well planned and carefully laid out, for no amount of statistical efficiency can yield reliable results from unreliable and meagre data. They should be repeated for a number of seasons and, if possible, under various sets of conditions. It is not very desirable to reject one or more treatments after a single year's experience on the plea that this treatment has proved inferior to the others. This fact as well as the method of calculating serial experiments will be illustrated by the yield trial with oats conducted by the writer at Pusa and Karnal during the period 1931-32 to 1933-34.

Eleven hybrids, A to K, and two selections, L and M, were tried in randomized blocks, for three consecutive years, under irrigated conditions at Karnal and non-irrigated conditions at Pusa. The following yields were recorded in the first year of the experiment :—

TABLE I

Total yields of Pusa oats taken from five plots, each 1,000 square feet in area (1931-32)

Locality	Yields and rank	Varieties												
		A	B	C	D	E	F	G	H	I	J	K	L	M
Pusa .	Yields in lb.	127·5	123·5	122·0	131·5	154·5	174·0	151·0	111·0	116·5	159·0	136·0	221·5	161·0
	Rank	9	10	11	8	5	2	6	13	12	4	7	1	3
Karnal .	Yields in lb.	206·5	146·5	210·5	203·0	178·5	172·0	218·5	182·5	164·0	221·5	197·0	159·0	178·0
	Rank	4	13	3	5	8	10	2	7	11	1	6	12	9

If we were to base our conclusions regarding the yielding powers of the oat types under trial, we would certainly say that for conditions such as those obtained at Pusa, Type L was the heaviest yielder and Type C a very indifferent one and if we were to reject the poor-yielding types once for all, Type C would easily go out. Considering the Karnal results, on the other hand, we note that Type C was one of the best yielders, whereas Type L was one of the worst, and if any types were to be thrown out of the experiment because of their poor behaviour, L would certainly be one of them.

Without rejecting any type from the experiment, this trial was repeated for three years at each place and the following yields based on plot areas of 1,000 square feet each were recorded.

It may be mentioned, however, that in combining the data at the two localities, it is assumed that they constitute a random sample of localities at which the crop could be grown, under weather conditions supposed to be represented by a random sample of 3 years under consideration. The number in the sample is obviously too small for any definite conclusions but the method of analysis indicated in the following pages will show how it is possible to extract maximum information from a data of this kind.

TABLE II

Yields of Pusa oats in lbs. from plots 1,000 square feet in area

Locality	Seasons	Blocks	A	B	C	D	E	F	G	H	I	J	K	L	M	Block Totals	Total sums of squares
Pusa	1931-32	1	26·5	35·0	29·5	39·5	39·5	43·0	37·0	30·5	28·5	36·5	28·5	51·0	43·0	466·0	
		2	38·0	28·5	24·0	24·0	31·5	44·5	33·0	18·5	26·0	38·5	40·0	59·0	28·5	434·0	
		3	22·5	23·0	23·5	21·0	26·5	26·0	22·0	22·0	27·0	30·5	24·0	39·0	20·5	336·5	
		4	18·0	17·5	19·5	22·0	27·0	28·0	31·5	18·5	19·5	35·0	23·0	34·0	32·0	315·5	
		5	22·5	19·5	25·5	25·0	30·0	32·5	27·5	21·5	15·5	28·5	22·5	38·5	28·0	337·0	
		Totals	127·5	123·5	122·0	131·5	154·5	174·0	151·0	111·0	116·5	159·0	138·0	221·5	162·0	1,889·0	59,445·50
	1932-33	1	37·5	25·0	61·0	35·0	44·5	48·5	53·0	41·0	51·5	61·0	36·5	59·0	59·0	615·5	
		2	31·5	37·5	55·5	36·0	47·0	48·5	55·5	27·5	47·0	56·5	41·0	53·5	59·0	596·0	
		3	28·0	30·5	61·0	46·0	37·0	53·0	57·0	32·5	51·0	58·5	28·0	51·0	54·5	593·0	
		4	32·5	34·5	60·0	51·0	50·5	47·5	55·0	37·5	62·5	56·5	33·0	55·5	54·0	630·0	
		5	40·5	29·5	58·0	57·5	52·5	49·0	51·5	31·5	53·5	51·0	47·5	43·5	59·5	624·0	
		Totals	170·0	147·0	295·5	235·5	231·5	251·5	272·0	170·0	268·5	283·5	186·0	261·5	286·0	3,048·5	150,618·75
	1933-34	1	37·5	30·5	68·0	41·0	47·0	43·0	52·5	42·5	44·5	49·5	42·5	61·5	66·0	626·0	
		2	45·0	35·5	71·0	52·0	57·0	45·5	55·5	51·5	55·5	55·5	46·5	57·5	57·5	691·5	
		3	49·0	38·0	67·5	52·5	57·5	48·5	59·0	48·0	52·0	51·5	48·5	55·0	63·5	690·5	
		4	54·0	35·5	68·5	54·5	60·0	49·0	57·0	52·5	54·0	56·5	49·0	69·0	70·0	732·5	
		5	48·0	32·0	64·5	49·5	49·0	38·0	56·5	48·0	48·0	67·5	42·5	54·5	62·0	660·5	
		Totals	236·5	174·5	339·5	249·5	270·5	227·0	280·5	242·5	254·0	280·5	229·0	297·5	319·0	3,400·5	183,579·75
Varietal totals for Pusa			534·0	445·0	757·0	608·5	656·5	652·5	703·5	523·5	639·0	723·0	551·0	780·5	766·0	8,338·0	

Karnal	1931-32	1	44·5	29·0	44·0	48·5	42·0	30·5	50·5	40·5	41·0	46·5	51·5	19·0	38·0	525·5	
		2	34·5	37·0	42·5	39·0	40·5	44·0	47·0	43·0	29·5	53·5	45·5	34·5	25·5	516·0	
		3	43·0	27·0	36·0	38·5	33·5	32·5	44·5	39·0	31·5	37·5	30·0	38·0	56·0	467·0	
		4	42·0	23·0	46·0	42·0	26·5	34·0	44·0	23·5	36·0	42·0	34·0	39·5	44·0	476·5	
		5	42·5	30·5	43·0	35·0	36·0	31·0	32·5	26·5	36·0	42·0	36·0	28·0	34·5	443·5	
		Totals .	206·5	146·5	210·5	203·0	178·5	173·0	218·5	182·5	164·0	221·5	197·0	159·0	178·0	2,437·5	94,786·25
	1932-33	1	29·0	27·5	36·0	30·5	35·0	36·0	46·0	27·5	33·0	45·0	32·0	56·5	55·0	489·0	
		2	36·0	22·0	45·0	45·0	43·0	34·0	48·0	33·0	34·0	57·0	38·0	47·0	58·0	543·0	
		3	38·0	29·5	47·0	47·0	48·0	42·0	53·0	45·0	36·0	57·0	42·0	64·0	62·0	610·5	
		4	40·0	29·5	55·0	45·5	50·0	40·0	57·0	43·5	40·5	50·5	40·5	65·0	52·5	609·5	
		5	40·0	22·0	52·5	43·5	42·0	35·5	48·0	31·0	34·5	59·0	40·0	47·0	60·0	560·0	
		Totals .	183·0	130·5	236·5	217·5	218·0	187·5	251·0	180·0	178·0	268·5	192·5	279·5	287·5	2,812·0	118,555·00
	1933-34	1	40·0	37·0	38·5	35·5	34·0	34·5	35·5	33·5	35·5	37·5	39·5	39·5	40·5	474·0	
		2	36·5	26·5	38·5	32·0	35·0	33·0	38·5	30·5	40·5	37·5	32·5	35·0	50·0	466·0	
		3	39·5	34·0	42·0	48·0	43·5	43·0	41·5	37·5	41·0	39·0	35·5	45·0	49·5	539·0	
		4	45·5	31·0	42·0	36·5	45·5	46·5	48·0	39·5	43·5	49·5	40·0	53·0	56·5	575·0	
		5	55·5	37·5	57·5	50·0	52·5	52·5	54·5	43·0	51·0	47·0	54·0	46·0	56·5	657·5	
		Totals .	217·0	156·0	218·5	205·0	213·5	209·5	218·0	184·0	218·5	210·5	201·5	218·5	253·0	2,731·5	117,704·75
Varietal totals for Karnal . .			606·5	433·0	667·5	625·5	610·0	569·0	687·5	546·5	558·5	700·5	591·0	657·0	718·5	7,971·0	
Combined varietal totals for Pusa and Karnal.			1,140·5	878·0	1,424·5	1,233·0	1,366·5	1,321·5	1,391·0	1,070·0	1,197·5	1,433·5	1,142·0	1,437·5	1,484·5	16,619·0	734,890·00

It will be noted from the preceding table that the variables under consideration are :—

(1) Localities—Pusa and Karnal.

(2) Seasons—1931-32, 1932-33 and 1933-34.

(3) Varieties—Hybrids A to K and Types L and M

(4) Blocks—5 replications of each type.

The variable-square method may be used for the determination of the sums of squares and the total variance as well as variances due to localities, seasons, varieties, and blocks are determined in the usual way by taking the sum of squares of the total yields of each item, localities, seasons, etc., dividing by the number of plots contributing to each total, deducting the correction factor and dividing the sum of squares so obtained by the appropriate degrees of freedom. Thus the variance due to seasons is :—

$$\left\{\frac{(4326\cdot5)^2 + (5860\cdot5)^2 + (6122\cdot0)^2}{130} - c.f.\right\} \div 2.$$

Having determined the variances for the individual items shown above, we have to calculate the interaction between any two of these variables taken together, and finally the interactions between any three of these items combined together. The sum of squares contributed by all these components deducted from the total sum of squares will ultimately yield the sum of squares for the residual error.

The interaction between any two variables such as blocks and localities is indicated by " blocks × localities " and is calculated as follows :—

TABLE III

Combined yields of blocks and localities

Blocks	Localities		Block totals
	Pusa	Karnal	
1	1707·5	1488·5	3196·0
2	1711·5	1525·0	3236·5
3	1620·0	1616·5	3236·5
4	1678·0	1681·0	3359·0
5	1621·0	1660·0	3281·0
Locality totals	8338·0	7971·0	16309·0

The block yields in each locality in the above table have been derived by adding together block yields of the three seasons in each locality. Thus the first block yield for Pusa, *viz.*, 1707·5=466·0 + 615·5 + 626·0 lb.

Total sum of squares for blocks and localities (9 degrees of freedom)

$$= \frac{(1707\cdot5)^2 + (1488\cdot5)^2 + (1711\cdot5)^2 \ldots\ldots + (1660\cdot0)^2}{39} - c.f.$$

$= 1278\cdot3544$

Sum of squares for blocks (4 *d. f.*)

$$= \frac{(3196\cdot0)^2 + (3236\cdot5)^2 \ldots\ldots + (3281\cdot0)^2}{78} - c.f.$$

$= 197\cdot7744$

Sum of squares for localities (1 *d. f.*)

$$= \frac{(8338)^2 + (7971)^2}{195} - c.f. = 345\cdot3564$$

$\therefore$ Interaction between blocks $\times$ localities (4 *d. f.*)

= Total S. S. blocks and localities—(S. S. blocks + S. S. localities)

$= 1278\cdot3544 - (197\cdot7744 + 345\cdot3564) = 735\cdot2236.$

We may note that the sum of squares due to the combined effects of blocks and localities is 1278·3544 and is much greater than the additive effect of these two variables as represented by their sums of squares taken together, *i.e.*, 197·7744 + 345·3564 or 543·1308. This suggests that the interaction of blocks and localities has exerted a definite influence on the variability of the experiment and must, therefore, be eliminated from the total sum of squares.

In this way the first order interactions between the undermentioned variables have to be calculated :—

(1) Blocks $\times$ localities

(2) Blocks $\times$ seasons

(3) Blocks $\times$ varieties

(4) Varieties $\times$ seasons

(5) Varieties $\times$ localities

and (6) Localities $\times$ seasons.

After this the second order interactions, or the interactions between three variables taken at a time, are to be calculated. They are interactions between :—

(1) Localities $\times$ seasons $\times$ varieties

(2) Localities $\times$ seasons $\times$ blocks

(3) Localities $\times$ blocks $\times$ varieties

and (4) Seasons $\times$ blocks $\times$ varieties.

Table IV shows the combined effect of localities $\times$ seasons $\times$ varieties.

TABLE IV

Combined yields of localities × seasons × varieties (excluding block effect)

Localities	Seasons	Varieties A	B	C	D	E	F	G	H	I	J	K	L	M	Seasonal totals	Locality totals
Pusa	1931-32	127·5	123·5	122·0	131·5	154·5	174·0	151·0	111·0	116·5	159·0	136·0	221·5	161·0	1959·0	
	1932-33	170·0	147·0	295·5	235·5	231·5	251·5	272·0	170·0	268·5	283·5	156·0	261·5	266·0	3048·5	
	1933-34	236·5	174·5	339·5	249·5	270·5	237·0	280·5	242·5	254·5	280·5	229·0	297·5	319·0	3400·5	8338·0
Karnal . . .	1931-32	206·5	146·5	210·5	203·0	178·5	173·0	218·5	182·5	164·0	221·5	197·0	159·0	178·0	2437·5	
	1932-33	183·0	130·5	238·5	217·5	218·0	157·5	251·0	180·0	178·0	268·5	193·5	279·5	28[illegible]·5	2813·0	
	1933-34	217·0	156·0	218·5	205·0	213·5	209·5	218·0	184·0	216·5	210·5	201·5	218·5	253·0	2721·5	7971·0
Varietal totals .		1140·5	978·0	1424·5	1332·0	1268·5	1221·5	1391·0	1070·0	1197·5	1433·5	1143·0	1437·5	1484·5	16309·0	16309·0

The varietal totals in this table have been secured by summing together the plot yields of each variety in all the five blocks in each experiment.

Total sum of squares for localities, seasons and varieties

$$= \frac{(127 \cdot 5)^2 + (123 \cdot 5)^2 \; \ldots\ldots + (253 \cdot 0)^2}{5} - c.f. = 41340 \cdot 0744.$$

Sums of squares for localities, seasons and varieties are 345·3564, 14475·2784 and 12297·1744, respectively. Interactions between seasons $\times$ localities, seasons $\times$ varieties, and varieties $\times$ localities are 5955·6086, 3839·0216 and 1314·1769, respectively.

Therefore the interaction between localities $\times$ seasons $\times$ varieties

= Total S. S. localities, seasons and varieties—(S. S. localities + S. S. seasons + S. S. varieties + interactions between seasons $\times$ localities + seasons $\times$ varieties + varieties $\times$ localities)

= 41340·0744—(345·3564 + 14475·2784 + 12297·1744 + 5955·6086 + 3839·0216 + 1314·1769)

= 3113·4781.

The complete analysis of variance is tabulated below :—

Analysis of variance

Due to	Degrees of freedom	Sum of squares	Mean squares	Mahalanobis' x or $\frac{v_1}{v_2}$ Observed	Expected at $P = 0 \cdot 01$ level
1. Blocks	4	197·7744	49·4436	2·3981	3·51
2. Localities	1	345·3564	345·3564	16·7504	6·90
3. Seasons	2	14475·2784	7237·6392	351·0384	4·82
4. Varieties	12	12297·1744	1024·7645	49·7029	2·37
Interactions—					
5. Blocks × localities	4	735·2236	183·8059	8·9149	3·51
6. Blocks × seasons	8	3175·2316	396·9039	19·2505	2·69
7. Blocks × varieties	48	1112·4589	23·1762	1·1241	1·43
8. Seasons × localities	2	5955·6086	2977·8043	144·4288	4·82
9. Varieties × seasons	24	3839·0216	159·9592	7·7583	1·98
10. Varieties × localities	12	1314·1769	109·5147	5·3117	2·37
11. Localities × seasons × varieties	24	3113·4781	129·7283	6·2921	1 98
12. Localities × seasons × blocks	8	1002·6014	125·3252	6·0785	2·69
13. Localities × blocks × varieties	48	897·2451	18·6926	0·9066	1·43
14. Seasons × blocks × varieties	96	2241·1351	23·3452	1·1323	1·43
15. Residual error	96	1979·3099	20·6178	..	
16. Total	389	52681·0744	135·4269		

After eliminating the variances due to individual variables and their first and second order interactions it is found that the residual error is considerably reduced. The total variance of the experiment is 135·4260 but after all possible eliminations the residual variance is reduced to 20·6178. In other words an improvement in precision of $\frac{135 \cdot 4269}{20 \cdot 6178}$ or 6·57 times is obtained by using this method of analysis.

The residual variance is 20·6178 and the standard error of the difference for each comparison is obtained by the square root of this number divided by n, the number of plots contributing to each total and multiplying this quantity by $\sqrt{2}$. The critical difference is obtained by multiplying this standard error of the difference by the value of 't' given in Fisher's tables for the 0·01 and 0·05 levels of significance, for the number of degrees of freedom equal to that for error.

It must be remembered, however, that the different items of variance in a table of analysis of variance, such as the one presented above, is such as could be separated out leaving a residual error and that the 'error' to be used as a basis for judging the general effect or for the comparison of individual varieties should be the one most appropriate for such comparisons. Thus, the residual error is the basis for inferring significance of the average effect in the yielding power of the different varieties through all seasons. The significance of the various items of variance in Table V have been shown by considering the mean square due to the residual error as the smaller variance but it is feasible to draw general inferences through successive stages as follows :—

TABLE V

Major item of variance	Basis of error for inferring significance	Remarks
1. Seasons, localities, blocks .	Residual error .	The average effect of seasons or localities is significant, while that of blocks is not significant
2. Varieties	Do. .	Average effect through all seasons is significant
3. Varieties × localities .	Do. .	Varieties show differential response in the two localities
4. Varieties × seasons . .	Do. .	Varieties show differential response in different seasons
5. Varieties × localities × seasons	Do. .	Varieties show differential response in different localities during different seasons

TABLE V—*contd.*

Major item of variance	Basis of error for inferring significance	Remarks
6. Varieties	(a) Varieties × localities (b) Varieties × seasons	The same varieties are consistently the best in the same localities in most years, or in the same years in most places
7. (a) Varieties × localities .	Varieties × localities × seasons	Relative effects of varieties are not uniform in the several localities or during several years
(b) Varieties × seasons .		

For the comparison of varieties, it seems useful to compare their yields on the basis of (a) varieties × localities and (b) varieties × seasons, in addition to a comparison on the basis of the residual error. In the present case the comparative effects of varieties remain the same whatever be the basis of error.

The following table shows that the mean yields per plot, per variety, in the two localities are respectively 42·76 and 40·88 lb., with a mean difference of 1·88 lb. The critical difference at the one per cent level of significance being only 1·1985 lb., the observed difference of 1·88 lb. is statistically significant, suggesting that the oats under trial have generally yielded higher at Pusa than at Karnal.

TABLE VI

Difference of mean yields per plot, per variety, at the two localities

Localities	Pusa	Karnal
Pusa	..	—1·88
Karnal	+1·88	..
Mean yields	42·76	40·88

$$\text{S. E. of difference} = \sqrt{\frac{20\cdot 6178 \times 2}{195}}$$

Critical difference at 1 per cent. level = S. E. difference × '*t*'=1·1985

Table VII shows the difference of mean yields per plot, per season and suggests that significantly higher yields were obtained in 1932-33 than in 1931-32, and that the yields produced in 1933-34 were significantly higher than those secured in the previous two seasons.

TABLE VII

Difference of mean yields per plot, per season, ignoring the locality effect

Seasons	1931-32	1932-33	1933-34
1931-32	..	+11·80	+13·81
1932-33	—11·80	..	+2·01
1933-34	—13·81	—2·01	..
Mean yields	33·28	45·08	47·09

$$\text{S. E. of difference} = \sqrt{\frac{20\cdot6178 \times 2}{130}}$$

Critical difference at 1 per cent level = S. E. difference × '*t*' = 1·4507

Table VIII provides all the possible sets of differences between mean yields of the varieties, irrespective of seasons and localities. Positive significant differences have been marked for the sake of convenience. Those that are statistically significant at the 1 per cent level of significance are double underlined while those that are significant at the 5 per cent level are underlined once only.

TABLE VIII

Differences of mean yields of different varieties, not taking into account seasons and localities

Varieties	A	B	C	D	E	F	G	H	I	J	K	L	M
A	...	—10·75	+9·46	+3·05	+4·20	+2·70	+8·35	—2·35	+1·90	+9·43	+0·05	+9·90	+11·46
B	+10·75	...	+18·21	+11·80	+12·95	+11·45	+17·10	+6·40	+10·65	+18·18	+8·80	+18·65	+20·21
C	—9·46	—18·21	...	—6·41	—5·26	—6·76	—1·11	—11·81	—7·56	—0·03	—9·41	+0·44	+2·00
D	—3·05	—11·80	+6·41	...	+1·15	—0·35	+5·30	—5·40	—1·15	+6·38	—3·00	+6·85	+3·41
E	—4·20	—12·95	+5·26	—1·15	...	—1·50	+4·15	—6·55	—2·30	+5·23	—4·15	+5·70	+7·26
F	—2·70	—11·45	+6·76	+0·35	+1·50	...	+5·65	—5·05	—0·80	+6·73	—2·65	+7·20	+8·76
G	—8·35	—17·10	+1·11	—5·30	—4·15	—5·65	...	—10·70	—6·45	+1·08	—8·30	+1·55	+3·11
H	+2·35	—6·40	+11·81	+5·40	+6·55	+5·05	+10·70	...	+4·25	+11·78	+2·40	+12·25	+13·81
I	—1·90	—10·65	+7·56	+1·15	+2·30	+0·80	+6·45	—4·25	...	+7·53	—1·85	+8·00	+9·56
J	—9·43	—18·18	+0·03	—6·38	—5·23	—6·73	—1·08	—11·78	—7·53	...	—9·38	+0·47	+2·03
K	—0·05	—8·80	+9·41	+3·00	+4·15	+2·65	+8·30	—2·40	+1·85	+9·38	...	+9·85	+11·41
L	—9·90	—18·65	—0·44	—6·85	—5·70	—7·20	—1·55	—12·25	—8·00	—0·47	—9·85	...	+1·56
M	—11·46	—20·21	—2·00	—8·41	—7·26	—8·76	—8·11	—13·18	—9·56	—2·03	—11·41	—1·56	...
Mean yields in lb.	38·02	29·27	47·48	41·07	42·22	40·72	46·37	35·67	39·92	47·45	38·07	47·92	49·48
Rank	11	13	3	7	6	8	5	12	9	4	10	2	1

S. E. of difference $= \sqrt{\dfrac{20\cdot6178 \times 2}{30}} = 1\cdot37452$

Critical difference at the 1 per cent level = 3·0188
Critical difference at the 5 per cent level = 2·2971

NOTE.—Only positive differences which are statistically significant are underlined in the above table.

The conclusions are obvious and a detailed recapitulation of the significant differences in the above table seems unnecessary.

The five highest yielders are shown as M, L, C, J, and G which are ranked in this order, but varieties L, C, J and G are not statistically different from each other and may all be classed as yielders of the same order. M is superior in yielding power to G only and not to any other type of these oats. We can safely conclude, therefore, that in C, J and G we have secured three hybrids in which the high-yielding capacity of the Pusa parents has been combined with the plump grain and other good qualities of the exotic parent. This is a very important finding and is one which could be secured only by conducting the experiment for a number of years under two different sets of conditions. The influence of season on the different varieties is very marked as will be evident from the yields of the different varieties obtained in the different seasons under both Pusa and Karnal conditions.

The above example should be sufficient to prove the fallacy of basing conclusions about the inherent yielding capacity of different varieties from the results of a single season and to show the necessity of conducting serial trials to produce results of average reliability.

Summary

The object of most varietal or manurial trials is to determine which particular treatment is the best for the particular conditions of the locality or climate under which the experiment has been conducted and generally on the results of such trials recommendations are based regarding improved varieties, manurial or cultural treatments. It is, however, not very safe to base recommendations on the results obtained from a single experiment conducted but for a single season as it is quite possible that the same treatment may respond differentially when subjected to varying soil and seasonal conditions. This fact is illustrated by the result of yield trials conducted with some Pusa oats simultaneoulsy at Pusa and Karnal for three consecutive seasons, and the method of combining and calculating such results in the form of a serial experiment is described in detail.

SELECTED ARTICLES

COMPARISON OF *GHEE* MAKING FROM CREAM AND BUTTER

BY

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It has been an established fact that the disposal of milk in the form of *ghee*—clarified butter—is not an economic proposition,* specially in cities where pure milk can be readily disposed at a price varying from 6 to 10 lbs. a rupee. However, when milk cannot be disposed off economically in any other form, specially in villages, it is required to be turned into *ghee.*

A systematic study has been made by the writer at the Poona Agricultural College Dairy in comparing the two methods of *ghee* making, *viz.*, from cream and from butter.

Material and methods.—(1) Buffaloes' milk of known fat percentage was separated at 91° F. to 92° F. by using a previously adjusted hand power cream separator Alfalaval No. 20.

(2) The cream obtained was divided into two equal lots "A" and "B" after thorough sampling so as to enable uniform distribution of butter fat in each lot.

(3) Cream of lot "A" was melted for *ghee,* while lot "B" was turned into butter which after working was clarified into *ghee.* Each lot of cream and butter was subjected to heat from 215° F. to 218° F. for *ghee* making.

(4) Time, labour and material required for various operations were recorded.

* *Vide* article on "The comparison of economics of disposal of milk and its products", *Agricultural College Magazine,* Vol. XXV, September 1933.

Results.—Day to day data of experiment are given at length in Appendix " A ", a consolidated review of which is given in the following table :—

TABLE I

Showing the outturn of ghee *from cream and butter*

No.	Name of dairy produce	Quantity in lbs	Percentage to milk
	(*a*) From cream		
1	Milk	525·50	..
2	Butter fat	40·411	7·69
3	Cream	78·50	14·93
4	Separated milk	444·25	84·53
5	*Ghee*	34·75	6·60
	(*b*) From butter		
1	Milk	525·50	..
2	Butter fat	40·411	7·69
3	Cream	78·50	14·93
4	Separated milk	444·25	84·53
5	Butter	46 97	8·94
6	Butter milk	87·25	16·60
7	*Ghee*	35·75	6·80

The above table shows that the average percentage of fat in milk is 7·69 and that the yield of cream and butter is about 15 per cent and 9 per cent of milk respectively. It is also seen that by converting 100 lbs. of milk into *ghee* by two different methods, *viz.*, from cream and butter, the latter yielded 0·2 lbs. more *ghee* than the former. The casein residue left after each clarification of cream

and butter was weighed separately and got analysed by the Agricultural Chemist to Government of Bombay, Poona, for the fat content as given below :—

TABLE II

*Showing the percentage of fat in casein residue from cream-*ghee *and butter-*ghee

Quantity of milk	Percentage of fat in milk	Dairy produce melted		Quantity of casein residue	Percentage of fat in casein	Quantity of fat in casein
		Name	Quantity			
lbs.			lbs.	lbs.		lbs.
525·50	7·69	Cream .	78·50	13·50	21·00	2·835
525·50	1·69	Butter .	46·97	0·81	36·05	0·292

It will be seen from the above table that the yield of cream-casein is more by about 17 times than that of butter-casein, which is due to its partial presence in cream, while the same is almost removed from cream by way of buttermilk during the process of butter making. With regard to the quantity of fat in each, it will be seen that the cream casein holds 10 times more butter fat than the butter-casein. It was also observed that the particles of cream-casein were of larger size than those of butter-casein.

Table III gives the financial aspect of the two methods of *ghee* making.

TABLE III

Showing the economic aspect of the two methods of ghee *making*

No.	Name of method	Name of dairy produce	Quantity	Rate	Gross value	Total gross value	Cost of production as per Appendix B	Net value realised	Net realisation per 100 lbs. of milk
			lbs.		Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs.
1	Cream-*ghee*	i. Separated milk .	444·25	20 lbs. a rupee.	22 3 5	48 4 5	3 7 11	44 12 6	8·521
		ii. *Ghee* .	34·75	0 12 0 per lb.	26 1 0				
2	Butter-*ghee*	i. Separated milk .	444·25	20 lbs. a rupee.	22 3 5	49 11 2	6 13 11	42 13 3	8·150
		ii. Butter-milk .	87·25	0 0 3 for 2 lbs.	0 10 9				
		iii. Ghee .	35·75	0 12 0 per lb.	26 13 0				

SUMMARY

(1) Cream-*ghee* fetches Re. 0·371 (4·55 per cent) more than that of butter-*ghee* for every 100 lbs. of milk.

(2) Butter-*ghee* possesses a peculiar pleasant aroma as compared with that of cream-*ghee*.

(3) Butter-*ghee* presented a uniform granular appearance with bigger grains, while in case of cream-*ghee* the grains were small, not uniform with greasy appearance, *i.e.*, the cream-*ghee* was wanting in qualities which the *ghee* market demands.

(4) For preparing one lb. *ghee* it required 2 lbs. fuel in the case of cream-*ghee* and 1½ lbs. in case of butter-*ghee*.

(5) There was a loss of 1·09 lbs. of fat from cream-*ghee* and 0·89 lbs. of fat from butter-*ghee* while converting 7·69 lbs of butter fat into *ghee* by the two different methods.

APPENDIX A

Showing day to day data of two methods of ghee *making,* viz., *from butter and from cream*

Date	Milk		Fat per cent		Yield of cream		Yield of separated milk		Loss of milk		Percentage of fat in separated milk		Quantity of cream churned	Yield of		Percentage of fat in butter-milk	Date of melting		Quantity melted		Yield of *ghee*	Yield of casein in residue	Quantity of fuel used
	AM lbs.	PM lbs.	AM	PM	AM lbs.	PM lbs.	AM lbs.	PM lbs.	AM lbs.	PM lbs.	AM	PM	lbs.	Butter lbs.	Butter-milk lbs.		Cream	Butter	Cream lbs.	Butter lbs.	lbs.	lbs.	lbs.
Butter-*ghee*																							
8-11-33	...	45½	...	8·2	...	8½	...	37	...	¼	...	trace	...	...	...	...	...	...	...	...	...	...	...
9-11-33	50	40	6·4	8·0	7¼	6¾	42½	33	¼	¼	trace	trace	...	...	...	...	...	...	...	...	...	...	...
10-11-33	50	50	6·2	8·8	6¾	7	43	42¾	¼	¼	trace	0·1	8½	4-5	12	0·1	...	...	...	...	...	...	...
11-11-33	50	50	7·5	8·3	7¾	7½	42¼	42¾	¼	¼	trace	trace	14¼	713½	21¼	0·5	...	13-11-33	...	20-14½	15¾	0·5	19
12-11-33	50	50	7·8	7·9	7½	7	42½	42¾	¼	¼	0·1	0·1	13¾	8-12	18¾	0·15	...	14-11-33	...	19-0	14¾	0·5	19
13-11-33	50	40	7·5	8·2	7¼	5¾	42½	34	¼	¼	0·05	0·1	...	...	...	...	...	...	...	...	...	...	...
14-11-33	...	...	...	...	...	...	...	...	...	...	...	...	29	19-0	28½	0·15	...	...	...	...	...	...	...
15-11-33	...	...	...	...	...	...	...	...	...	...	...	...	13½	7-1	7	0·1	...	15-11-33	...	7-1	5¼	0·3	7
Total	250	275½	...	...	36½	42¼	212½	231¾	1¼	1½	...	...	...	...	...	...	...	...	...	...	...	...	...
Grand Total	525½		...	...	78¾		444¼		2¾		...	...	78¾	46-15½	87½	...	...	...	...	46-15½	35¾	0·13	45
													78¾	46-15½	87½	...	...	...	...	46-15½	35¾	0·13	45
Cream-*ghee*																							
8-11-33	...	45½	...	8·2	...	8½	...	37	...	¼	...	trace	...	...	...	...	...	...	...	...	...	...	...
9-11-33	50	40	6·4	8·0	7¼	6¾	42½	33	¼	¼	trace	trace	...	...	...	...	...	...	...	...	...	...	...
10-11-33	50	50	6·2	8·8	6¾	7	43	42¾	¼	¼	trace	0·1	...	...	...	...	...	...	...	...	...	...	...
11-11-33	50	50	7·5	8·3	7¾	7½	42¼	42¾	¼	¼	trace	trace	...	...	...	...	...	...	...	...	...	...	...
12-11-33	50	50	7·8	7·9	7½	7	42½	42¾	¼	¼	0·1	0·1	...	...	...	...	12-11-33	...	36½	...	15	6-4	33
13-11-33	50	40	7·5	8·2	7¼	5¾	42½	34	¼	¼	0·05	0·1	...	...	...	...	14-11-33	...	42¼	...	19½	7-4	34
Total	250	275½	...	...	36½	42¼	212½	231¾	1¼	1½	...	...	...	...	...	...	...	...	78¾	...	34½	13-8	67
Grand Total	525½		...	...	78¾		444¼		2¾		...	...	...	...	...	...	...	...	78¾	...	34½	13-8	67

APPENDIX B

Showing the cost of manufacture of dairy produce

Serial No.	Name of dairy produce	Depreciation and interest *vide* Appendix C	Labour and material *vide* Appendix D	Total cost
		Rs. A. P.	Rs. A. P.	Rs. A. P.
1	Cream-*ghee* . .	0 6 9	3 1 2	3 7 11
2	Butter-*ghee* . .	2 9 8	4 4 3	6 13 11

APPENDIX C

Showing interest on capital and depreciation on appliances used

Serial No.	Name of dairy appliances	No.	Purchased price	Rate of depreciation per year	For six days: Interest on capital 9 per cent	For six days: Depreciation	Total
			Rs. A. P.	Per cent	Rs. A. P.	Rs. A. P.	Rs. A. P.
1	Cream separator Alfalaval No. 20.	1	120 0 0	10	0 2 10	0 3 2	0 6 0
2	Champian Churn No. II.	1	140 0 0	50	0 3 3	1 2 5	1 5 8
3	Butter worker .	1	100 0 0	25	0 2 4	0 6 7	0 8 11
4	Butter making appliances— one butter scoop, one cream squeeze, one pair Scotch, bands, one dairy Thermometer, one butter-sieve, three washing brushes.		150 0 0	100	0 0 4	0 4 0	0 4 4
5	*Ghee* making vessel	1	15 0 0	10	0 0 4	0 0 5	0 0 9
	TOTAL .	..	..	.	0 9 1	2 0 7	2 9 8

Appendix D

Showing labour and material required for various operations

Date	Male labour required for: Separation of milk hours	Male labour required for: Butter making hours	Labour and material required for *ghee* making from: Cream — Labour: Male hours	Cream — Labour: Female hours	Cream — Material (fuel)	Butter — Labour: Male hours	Butter — Labour: Female hours	Butter — Material (fuel)
					lbs.			lbs.
8-11-33 . .	1½	...	...	...	...	...	...	...
9-11-33 . .	3	...	...	...	...	...	...	...
10-11-33 . .	3	1½	...	...	...	...	...	...
11-11-33 . .	3	1½	...	...	...	...	...	...
12-11-33 .	3	1½	1½	2	33	...	...	...
13-11-33 . .	3	...	...	...	...	1	1½	19
14-11-33 . .	...	½ 1½	1½	2	34	1	1½	19
15-11-33 . .	...	1½	...	...	...	½	1½	7
Total .	16½	8	3	4	67	2½	4½	45
Cost Rs. .	3 1 6	1 8 0	0 9 0	0 2 0	0 13 5	0 8 3	0 2 3	0 9 0
Rs. 0-3-0 per male per hour Rs. 0-0-6 per female per hour			1 8 5			1 3 6		

RELATIONSHIP BETWEEN AGE, FECUNDITY AND HATCHABILITY

BY

J. HOLMES MARTIN

AND

W. M. INSKO, J.R.,

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(Reprinted from *the Harper Adams Utility Poultry Journal*, Vol. XIX, No. 7)

Fertility, hatchability, and production records of S. C. White Leghorn hens are given. These hens were selected on the basis of production, hatchability, egg size, vigour, and freedom from disqualifications. The minimum record for hens used in this test was 200 eggs in the pullet year and 450 eggs in the first three years. Most of the birds exceeded considerably these minimum requirements. Pullet hatching records are not available since no eggs were set until the yearling year. The records are given in the following table :—

Age	No. hens	No. eggs set	Fertility	Hatch	Hatch-ability	Chicks per hen
			Per cent	Per cent	Per cent	
2	159	5,892	89·1	58·6	65·8	21·7
3	99	3,408	86·8	50·8	58·5	17·5
4	84	2,292	77·4	46·5	60·1	12·8
5	60	1,097	83·1	56·7	68·2	10·3
6	39	707	77·8	57·6	74·0	10·4
7	11	220	85·0	58·6	60·0	11·7
8	3	43	62·8	51·2	81·5	7·3

While there was a trend toward lower egg records as age increased, yet in no case did the average production drop below 100 eggs. The three 8-year-old hens averaged 103·3 eggs in their seventh year and the eleven 7-year-old hens 118·3 eggs in their sixth year.

ABSTRACTS

Studies in the technique of field experiments. II. Sampling for staple length determination in cotton trials. With a note on the standard error of estimates of ginning percentage. J. B. HUTCHINSON and V. G. PANSE. (*Ind. J. Agric. Sci.* **5, 545**)

(1) Information was collected on halo-length plot by plot in replicated variety trials. Combing was done by girls trained for the purpose, and measurements were made by skilled observers.

(2) Similar data were collected on halo-lengths of single plants. Combing was done by the same girls, but some sets of measurements were made by semi-skilled laboratory assistants.

(3) It is shown that with skilled observers, five measurements per plot, or per plant, are adequate to give a standard error of the mean of 0·5 mm.

(4) Laboratory assistants varied greatly in their efficiency as measured by the standard error of the means of their observations, indicating the necessity of careful training and periodical checking of such subordinate staff.

(5) In replicated plot trials with measurements by skilled observers, within-plot variation was responsible for only a small proportion of the error variance. Sampling for staple length measurement should, therefore, be plot-wise, and not from the pooled product of all plots of a variety. (*Authors' abstract*).

Studies in the technique of field experiments. III. An application of the method of co-variance to selection for disease resistance in cotton. J. B. HUTCHINSON and V. G. PANSE. (*Ind. J. Agric. Sci.* **5, 554**)

An experiment in an investigation of the resistance of cotton strains to root-rot disease is described, in which alternate rows of all plots were sown with a uniform control strain.

Details are given of the application of the method of co-variance to the data obtained.

The error variance was, in general, reduced to about one half by adjustment for the co-variance of control and variety rows, giving the same advantage as would be obtained by doubling the number of plots.

The scope and advantages of the method are briefly discussed. (*Authors' abstract*).

A preliminary note on the classification of cultivated Indian mustards. T. S. Sabnis and M. G. Phatak. (*Ind. J. Agric. Sci.* 5, 559)

(1) The cultivated Indian mustards belong to *Brassica juncea* L., *Brassica campestris* L. and *Brassica napus* L. They have been classified. The principal works on the subject have been reviewed in the introductory chapter.

(2) The species have been divided into varieties which have again been subdivided into types—ten under *B. juncea*, twenty four under *B. campestris* and four under *B. napus*.

(3) The species and their varieties are fully described and a key to the types has been worked out.

(4) The type specimens of different varieties and of the new types have been fully described.

(5) The appendix contains a few observations on the cultivation, flowering and pollination of these mustards.

(6) The localities from which the original seed samples were obtained are also recorded in an appendix. This information will be helpful in understanding the geographical distribution of the Indian mustards. (*Authors' abstract*).

Some soil-heterogeneity trials at Pusa and the size and shape of experimental plots. R. D. Bose. (*Ind J. Agric. Sci.* 5, 579)

Results are reported of soil-heterogeneity experiments conducted for three consecutive years in the same field at Pusa with barley, wheat and lentils.

The co efficient of correlation between contiguous plots was employed as an index of soil-heterogeneity according to Harris' method and 1 × 5 and 2 × 5 combination plots were made up for this purpose. Although the coefficients of correlation for these two kinds of combinations were not significantly different from one another the presence of significant coefficients for each combination denotes definitely that the field under consideration was not absolutely uniform.

Fisher's analysis of variance was also employed to determine the drift in the fertility of the field with the same data. It was found that there was a great deal of variation in the yields for columns and very little in the rows suggesting that there was a fertility gradient in this particular field which ran from west to east. This was further seen when contour maps of soil fertility were drawn from results of plot yields.

It is shown that Harris' method of determining soil-heterogeneity provides a measure of heterogeneity present in the whole field but Fisher's analysis of variance not only provides a measure of soil-heterogeneity but also clearly sets forth the direction of the fertility gradient and should, therefore, be a more comprehensive method for such work.

A knowledge of the amount and direction of variability in the fertility of any experimental field helps in the proper laying out of yield or manurial trials in the right direction and gives a measure of the size and shape of plot which ought to be employed. The results of the wheat trial have been employed to illustrate this fact. (*Author's abstract*).

Influence of temperature and maturity on the incidence of sann hemp and pigeon pea wilt at Pusa. B. B. MUNDKUR. *(Ind. J. Agric. Sci.* **5, 609)**

Wilt in sann hemp and pigeon peas is caused at Pusa by *Fusarium vasinfectum* Atk. Weekly records of deaths in the two crops indicated that high soil temperatures, 28·33°C., favoured the disease in sann hemp and low soil temperatures, 17·29°C., favoured the disease in pigeon peas. The simple and multiple coefficients of correlation gave significant values and further indicated that in sann hemp the correlation is positive and in pigeon peas, it is negative. It became apparent that sann hemp plants became resistant as they matured while the pigeon pea plants became increasingly liable to attack by the fungus as they matured. It was also found that the values of partial coefficient of correlation between wilt incidence and soil temperature eliminating the effect of maturity or between wilt incidence and maturity eliminating the effect of soil temperatures, were not significant, showing that the influence of soil temperature and maturity was a combined one. *(Author's abstract)*.

A note on the inheritance of sterility in cotton. J. B. HUTCHINSON and P. D. GADKARI. *(Ind. J. Agric. Sci.* **5, 619)**

Two sterile rogues appeared in a pure culture of "Million Dollar" cotton grown in Trinidad B. W. T. One of these sterile plants was distinguished from the rest of the population by its large flowers and complete sterility. The other could not be distinguished from the rest of the crop except by its almost complete sterility. A progeny of eleven plants was obtained from this plant. All were highly sterile; one was abnormal in appearance. Examination of pollen under the microscope showed that a very high proportion of grains was shrivelled and collapsed.

A fertile F_1 was obtained by crossing with normal Million Dollar.

F_2, back-cross and F_3 data showed that sterility was inherited as a simple mendelian recessive. *(Authors' abstract)*.

Investigations on the wound-parasitism of certain *Fusaria*. ANIL MITRA. *(Ind. J. Agric. Sci.* **5, 632)**

The writer collected a number of *Fusaria* growing saprophytically. To test their parasitic properties apples and potatoes were inoculated with six species of *Fusarium*, *viz.*, *F. camptoceras*, *F. viride*, *F. diversisporum*, *F. incarnatum*, *F. semitectum* and *F. moniliforme*. *F. moniliforme* was found after 35 days at room temperature (19·5°—22·8°C.) to cause a great amount of rot (22·01 per cent) in both the "Kashmir" and "Hill" varieties of apples. Potatoes on the other hand were attacked only by *F. viride* (*F. solani* var. *medium* Wr.) which caused a dry rot. Saltants tested exhibited the same virulence as their respective parents. As the *Fusaria* that showed parasitic activities were capable of growing saprophytically it is possible that if they cannot infect healthy fruits and tubers, they may still cause a rot by getting into their tissues through accidental wounds. So far as the knowledge of the

writer goes there has been no previous report about *F. moniliforme* and *F. viride* (*F. solani* var. *medium*) as showing wound-parasitism of apples and potatoes respectively. (*Author's abstract*).

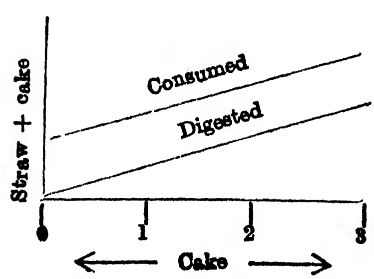
Studies on *Pennisetum typhoides* (Burm.) Stapf and Hubbard [Syn. P. typhoideum (Rich.)], the pearl millet. Part II. Spikelet bearing bristles. G. N. RANGASWAMI AYYANGAR, V. GOMATHINAYAGAM PILLAI and P. V. HARIHARAN. (*Ind. J. Agric. Sci.* **5, 638**)

In *Pennisetum typhoides* (Burm.)—the pearl millet—spikelet bearing bristles have been met with. Their examination sets down the bristle as the prolongation of the fascicle axis. The spikelet is borne as an appendage, near the end of this prolongation. (*Authors' abstract*).

Studies on the determination of digestibility co-efficients. I. A new method of experimentation and computation for directly obtaining the digestibility co-efficients of individual feed nutrients in a mixed ration. M. CARBERY, INDUBHUSAN CHATTERJEE and MD. ABDUL HYE. (*Ind. J. Vet. Sci. and Anim. Husb.* **4, 295**)

The authors have first given a resume showing the difficulties associated with the prevailing method of calculating digestibilities in a single feed or in a mixture of more than one feed. It has been shown that the digestibility values obtained from a deficient feed, when applied (as is often the procedure) to calculate the individual digestibilities of mixed feed, give unreliable results. The results with assumed digestibilities from foreign publications are not always applicable under local conditions.

These difficulties led the authors to make a new experimental design based on graphical representation and multiple regression equation. For this purpose six bullocks were divided into three pairs and each pair was put in turn under 1-lb. 2-lb and 3-lb cake in a restricted randomised cyclic order. Paddy straw given *ad lib.* was the roughage and linseed cake was the concentrate. In this way eighteen values were obtained, six under 1-lb, six under 2-lb and six under 3-lb combinations of cake. These values were first worked out graphically as follows :—



Here the x axis represents the different dose of cake consumed and y axis the combinedconsumption of both straw and cake. The upper curve represents total consumption and the lower curve total digestion. By extrapolation the amount consumed and digested from straw is obtained whereas the amount digested from cake is obtained from the slope of the lower curve. In this way each of the individual components, *viz.*, dry mattor, organic matter, crude protein, ether extract, crude fibre and nitrogen-free extract, has been separately plotted out with the circle of error on mean.

As a natural corollary to graphical method, the results have been also worked out by multiple regression equation.

In the case of straw and cake there were two unknowns. If a and b represent the digestible fractions of straw and cake respectively the linear relation is obtained as follows :

$$y = ax_1 + bx_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where y = amount digested from straw and cake, x_1 = amount consumed from straw and x_2 = amount consumed from cake.

By the application of Gauss's method equation (1) is converted into

$$\Sigma x_1 y = a\Sigma x_1^2 + b\Sigma x_1 x_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\Sigma x_2 y = a\Sigma x_1 x_2 + b\Sigma x_2^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

On these two equations the summations of the values of $x_1 y_1$, $x_2 y_2$, $x_1 x_2$, etc., have been applied and then by solving the equations the numerical values of a and b, *i.e.*, the digestibilities of straw and cake have been worked out. In this way the individual digostibilities of all components have been obtained ; and the statistical analysis of calculated and actual total digestion have given very satisfactory correlation co efficients, except in the case of crude fibre which is the only solitary instance where the result has been unsatisfactory. The cause of it has also been suggested. The method of calculation has been fully described in appendix IV.

On the whole the results appear to be highly encouraging and is likely to remove a long felt want since it obviates the necessity of conducting separate trials by single feed followed by combined feed thus enabling direct estimation of individual digestibilities in a mixed ration. (I. C.).

The relation of fruiting to vegetative growth characters in Carabao mango, *Mangifera indica* L. F. G. Galang and Felix D. Lazo. (*The Philippine Journal of Agriculture,* Vol. 6, No. 1.)

From the observations made there seems to be little doubt that the growth characters of the shoots and the number and area of the leaves of the Carabao mango tree are associated with its fruiting ability. The following conclusions may be deduced from the foregoing data :

1. There is a relation between the length and diameter of the twigs with fruiting. It is apparent that in the case of the non-bearing robust trees in this test there were an abundance of vegetative growths of the twigs—length and diameter—compared

with the bearing trees. On the other hand, the average length and diameter of the twigs were less on the non-bearing unthrifty trees than on the bearing trees, except in a few cases where the diameter was a little more than those of the bearing twigs.

2. There is a relation between the leaf area and the number of leaves with fruiting. As the number of leaves increases, each with a less leaf area, the less fruitful the tree becomes as in the case of the non-bearing robust trees. On the other hand, as they diminish both in number and dimension as in the case of the non-bearing unthrifty trees the less the trees become fruitful.

3. In the case of the bearing trees the average length and diameter of the bearing twigs were greater than those of the non-bearing twigs. And also there were more leaves but with less leaf area. (*Extract of the authors' conclusions*).

NOTES

THE WOODHOUSE MEMORIAL PRIZE

We have received the following announcement from the Director of Agriculture, Bihar and Orissa :—

In memory of Mr. E. J. Woodhouse, late Economic Botanist and Principal of Sabour Agricultural College, who was killed in action in France in 1917, a biennial prize in the form of a silver medal and books of a combined value of Rs. 100 will be awarded to the writer of the best essay on a subject of botanical interest to be selected from the list noted below. The length of the essay should not exceed 4,000 words.

The competition is open to graduates of Indian Universities and to Diploma holders and Licentiates of recognised agricultural colleges in India who are not more than 30 years of age on the date of submission of their essays.

Papers should be forwarded to the Director of Agriculture, Bihar and Orissa, Patna, before November 1st, 1935.

Failing papers of sufficient merit no award will be made. Essays must be type-written on one side of paper only.

1. Intergeneric hybrids and their importance to agriculture.

2. The problem of rust of wheat in India.

3. The constancy of agricultural and botanical characters of paddy and their suitability for being used in a scheme of classification.

4. Rotation of crops in relation to the eradication of weeds.

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MEETING OF THE PERMANENT COMMITTEE OF THE INTERNATIONAL INSTITUTE OF AGRICULTURE

The Permanent Committee of the International Institute of Agriculture at its Summer meeting recently concluded, after disposing of several questions of internal interest, then treated other subjects of an international order.

The Committee resolved to collaborate with the Hygiene Organisation of the League of Nations, with the object of arranging an International Exhibition of Rural Housing, to be held in Rome under the auspices of the Italian Government in 1936.

It also made certain modifications in the regulations for the Agricultural Economic Committee, one of the Institute's consultative organs, in order to secure more expeditious working, and received a report on the results of the International Diplomatic Conference for the standardisation of the methods of wine analysis in international trade, results to which considerable publicity has already been given.

In addition the Permanent Committee approved the report of the last meeting of the Joint Agricultural Consultative Committee held at Geneva, 28-29, May. This body is an organ of liaison between the Institute at Rome and the International Labour Office.

The Committee also arranged for the representation of the Institute at various International Congresses to be held during the summer and autumn of the current year, and decided to invite the 6th International Congress of Horticulture to use the assembly hall and committee rooms of the Institute for the purposes of its forthcoming meeting.

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PLANT QUARANTINE IMPORT RESTRICTIONS OF THE REPUBLIC OF ARGENTINA

The following Supplement No. 2, dated March 9, 1935, issued by the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine, Washington, D. C., is published for general information.

PLANTS AND PLANT PRODUCTS FOR WHICH A PHYTOSANITARY CERTIFICATE AND AN IMPORT PERMIT ARE REQUIRED

Recently issued Argentine customs regulations, based on the Decree of May 6, 1932, as amended by that of July 7, 1933 (see page 6, B. P. Q. 357) amplify paragraph 1 of article 1 of the decree of May 6, 1932, as amended, by furnishing the following list of plants and plant products which must be certified for export to Argentina :—

Almonds
Aniseed
Barley
Beans
Beet roots
Birdseed
Cacao bark
Cacao beans
Cane sugar
Fruits (fresh or frozen)
Fruits (dried, in general)
Garlic
Hazelnuts
Herbs (aromatic and nonmedicinal)
Herbs in general, obtained from plants
Lupines
Malt.
Marjoram (wild)

Carob beans (*Ceratonia siliqua*)
Cereals for food purposes
Chestnuts
Chicory coffee
Chufa (*Cyperus esculentus*)
Cinnamon
Clove-flower seeds
Cloves
Coconuts
Coffee beans
Corn
Flax
Raisins
Rice
Rice bran
Rice refuse or residuum
Rye
Saffron
Seeds (ground and their hulls)
Millet
Nuts (shelled or unshelled)
Peas (green, whole, shelled, or crushed)
Peanuts
Peppers in general
Peppers (chilli, whole or crushed)
Pine kernels
Pistachios
Potatoes
Prunes
Seeds for propagation
Stock feeds (nutriment for live-stock herbs and shoots of vegetables and plants)
Vegetables (not preserved)
Wheat (whole or crushed)
Yerba mate (*Ilex paraguensis*)

Also plants (live, and their parts, including cuttings, root-stocks, shoots, roots, bulbs, tubers, leaves ; fruits, fresh, dried or dissected ; seeds, etc., intended for propagation, consumption, or for industrial or medical use).

From the above it would appear necessary for the shipper of any of the above-named products to transmit with each shipment a duly visaed certificate. In this connection, inspectors will continue to be guided by Foreign Plant Quarantines Memorandum No. 12. The special bilingual certificates will be used for fresh fruits only, and the standard form No. 375 will be used for all the other products mentioned above.

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* *

RESTRICTION OF IMPORTS INTO THE U. S. S. R. OF SEEDS AND PLANTING MATERIAL, PLANTS AND AGRICULTURAL PRODUCTS

Translation of Decree No. 1232, dated the 28th February, 1935, of the People's Commissariat for Agriculture, U. S. S. R.

I. Imports into the U. S. S. R. of the following articles are prohibited :

1. Potatoes for consumption or for seed, bulbs, tubers and vegetables, in view of the great prevalence abroad of potato cancer, the potato moth, and the

Colorado-beetle and other diseases subject to quarantine regulations —diseases which are non-existent in the U. S. S. R.

Remarks :—For the purpose of carrying out scientific research work, the All-Union Institute for Plant Cultivation (Yaskhnil) is authorised to receive the above-mentioned articles from forwarding agencies, foreign firms and correspondents, either as indents or on the basis of an exchange agreement, provided the following regulations are strictly observed :—

A. The samples must be entirely free from infection of the diseases mentioned in the quarantine regulations and must be sent together with a certificate to this effect in cases where such samples are received from the countries in which plant quarantine or protection measures are in force ;

B. Such material may be imported only through the following points :

(*a*) potatoes *via* Leningrad ;

(*b*) sweet potatoes *via* Leningrad or Moscow ;

(*c*) other vegetables *via* Leningrad, Moscow or Odessa or Vladivostock ;

(*d*) samples must not exceed 5 kilos net in weight.

2. Citrus planting material from the following countries, where citrus cancer is prevalent :—Australia, the Hawaiian Islands, India, Indo-China, the Malay States, Siam, the Philippine Islands, Formosa, Ceylon, South Africa, Java and Japan.

3. Citrus fruit from the countries mentioned in paragraph 2 into the Georgian, Azerbaijan, Turkmen, Tadzhik and Uzbek Soviet Socialist Republics and the Azov-Black Sea District.

4. Melons and water-melons from Persia and countries infected by the melon fly—into the Turkmen Soviet Socialist Republic and the Stalingrad district.

II. Imports into the U. S. S. R. of the undermentioned goods and materials, which are subject to quarantine inspection, are permitted to enter only *via* the following custom-houses, ports and frontier stations :—

1. Cotton seed, irrespective of its origin or destination *via* Leningrad.

2. Cotton fibre :—

(*a*) imported from North or South America *via* Murmansk or Leningrad;

(*b*) from Egypt, Turkey or Syria *via* Odessa ;

(*c*) from the Igdyr district of Turkey *via* Markara ;

(*d*) from Persia *via* Haudan (to Ashkabad) or Baku.

Remarks :—From 1/XI to 1/IV the import of Persian cotton is permitted *via* Artuyk, Julfa and Shchakhtakhty.

(*e*) from Afghanistan *via* Termez ;

(*f*) from Western China *via* Bakhta, Khorgos (to Sufi-Kurgan, Karakol and Rybachiye).

3. The following planting materials—citrus, excluding imports from the countries enumerated in paragraph 2 of Section I, fruit and berries, sub-tropical, decorative and forestry species and of other live plants—*via* Leningrad, Moscow, Niegoreloye to Minsk, Bigosovo, Odessa, Batum, Poti, Sukhum, Baku, Termes, Haudan to Ashkabad, Hyat-Khodzhi Kzyl-Atresky Region, and Vladivostock.

Remarks :—The import of goods and materials subject to quarantine measures and the inspection thereof shall be carried out according to the existing regulations, rules and instructions regarding the application of quarantine measures against agricultural and forestry pests and diseases and against weeds.

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BELGIAN DECREE FOR SECURING FAIR DEALING IN AGRICULTURAL AND HORTICULTURAL PRODUCE

The following Decree issued by the Government of Belgium is published for general information :—

(*From the Echo de La Bourse of 3rd/4th March 1935*)

Royal decree with the object of securing fair dealing in agricultural and horticultural produce

Report to the King :—Your Majesty, Belgian agriculture, realising the important part it has to play in the nation's finance, continues to defend itself perseveringly and bravely against the difficulties imposed by the crisis and by foreign competition.

But in modern times, Government intervention is inevitable if we are to safeguard the markets for home-reared and home-grown articles ; and in this connection there is a call for an assurance of fair dealing and a guarantee to the consumer of the quality of the produce. It cannot be denied that the lack of such a guarantee is a serious handicap to our rural economy.

Most countries have already taken drastic measures to popularise and to increase the sales of home-produced articles, and to restrict the distribution of foreign agricultural produce.

The draft of the attached decree will to a certain extent allow such steps to be taken as the requirements of the internal and external trade in Belgian agricultural products demand.

Text of the Decree :—By virtue of the first article, section III (*c*) and (*d*) of the Law dated 31st July 1934, as prolonged and completed by those dated 7th December 1934, by which certain powers for economic and financial reform and the lowering of public expenditure were assigned to the King

At the suggestion of Our Cabinet,

We have decreed and do decree :

Article I.- Such agricultural and horticultural produce as Our Minister of Agriculture shall specify shall not be offered or exposed for sale, sold, delivered, imported or exported, unless the country of origin, and the quantity and quality of the goods are clearly shown.

Our Minister of Agriculture will define these conditions; he will lay down the steps to be taken by the administration to secure control, and the rules to be observed by individuals in order to give reality to the control In particular, he will define the methods by which certain articles are to be offered to the public.

Article II—Without prejudicing the powers of the judicial police officials, the gendarmes or the parochial police officers and constables—the state agricultural officers, the state advisers in live-stock-rearing, the state veterinary inspectors, the state advisers in horticulture, the officers of the special phyto-pathological service and the customs officials, are specially detailed to discover and report infringements of the decrees passed under the authority of article I and infringements of article IV.

Judicial police officials and the officers and constables defined in the above paragraph have the right of access to warehouses, stalls, depots, dumps, stations, trucks, and vehicles They may take away samples. Public bodies, transport contractors, agriculturists and horticulturists and traders, with their subordinates are bound to give them information and to forward to them any useful documents.

Article III.—Infringements of the decrees passed under the authority of article I will be punished by imprisonment for eight days up to a month and a fine of 26 to 1,000 francs; or by either of these penalties singly.

The produce will be confiscated if it belongs to the guilty person, to his employer, or to the society or association on whose behalf he offered or exposed it for sale, sold it, delivered it, imported or exported it.

In the case of a second offence the term of imprisonment and the fine may be doubled.

Article IV.—Without prejudicing the application of the severest penalties allowed by the criminal code, the following will be punished by imprisonment for

a fortnight up to six months and a fine of 100 to 2,000 francs, or by either of these penalties singly :—

1. Any one who forges or falsifies, or makes fraudulent use of any certificate mark, label or sign specified or permitted, by Our Minister of Agriculture in any decree made under the authority of article I ;

2. Any one who, in a certificate swears falsely to the country of origin, quantity and quality of any agricultural or horticultural produce offered or exposed for sale, sold, delivered, imported or exported by him ; or who makes fraudulent use of any such certificate ;

3. Any one who knowingly offers or exposes for sale, sells, delivers, imports or exports agricultural or horticultural produce, which he pretends or falsely alleges to be controlled by the authorities, or affirms it to be so by means of an invoice or label, or by means of a method of packing or any other procedure calculated to deceive as to its country of origin ;

4. Any one who resists the inspections and removal of samples mentioned in article II ; any one who refuses to give information or to furnish documents demanded from him by virtue of that article, or who knowingly gives incorrect information or furnishes incorrect documents.

Produce concerned in an offer or exposal for sale, a sale, a delivery, an importation or an exportation vitiated by any of the infringements defined in I and III, is confiscated when it is the property of the guilty person, his employer or the society or association for whose benefit he offered or exposed it for sale, sold it, delivered it, imported or exported it.

The court may order the sentence to be published in one or more papers, or to be placarded in such places and for so long as they may think fit, at the expense of the guilty party.

In the case of a second offence, the term of imprisonment and the fine may be doubled, and the court may order the closing for a week to a year of the premises of the guilty party, his employer or the society or association for whose benefit he offered or exposed for sale, sold, delivered, imported or exported the produce.

Article V.—A second offence, for the purposes of articles III and IV is deemed to have been committed when the second infringement occurs less than five years after a sentence delivered under the authority of the present decree has acquired the force of statute.

Article VI.—Book I of the criminal code, not excepting chapter 7 and article 85, is applicable to infringements of the present decree.

Article VII—Our Minister of Agriculture is to put the present decree into force.

Given at Brussels. 26th February 1935.

THE STANDARDIZATION OF THE METHODS OF WINE ANALYSIS

There was recently held in Rome at the International Institute of Agriculture an International Diplomatic Conference, which resulted in an International Convention for the Standardization of Wines in international trade. This Conference was the outcome of a resolution of the Monetary and Economic Conference of London, June 1933, and was held in conjunction with the International Wine Office. The representatives of 12 States were present and the Convention itself has been lodged with the Ministry of Foreign Affairs of Italy, where it is open for signature by other States interested.

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THE MAYNARD-GANGA RAM PRIZE.

In 1925 the late Sir Ganga Ram, Kt., C. I.E., M.V.O., R.B., Lahore, with that generosity for which he was so well known, handed over to the Punjab Government a sum of Rs. 25,000 for the endowment of a prize of the value of Rs. 3,000 to be called the Maynard-Ganga Ram Prize and to be awarded every three years, for a discovery, or an invention, or a new practical method which will tend to increase agricultural production in the Punjab on a paying basis. The competition is open to all throughout the world. Government servants are also eligible to compete for it.

Entries for the next award were invited by the 31st December, 1933. None of the entries was considered to be of sufficient merit and it has been decided by the Managing Committee of the prize that the award should be postponed for another year and that further entries should reach the Director of Agriculture, Punjab, Lahore, on or before the 31st December, 1935.

Applications are invited for " The Maynard-Ganga Ram Prize " of the value of Rs. 3,000 which will be awarded for a discovery, or an invention, or a new practical method tending to increase agricultural production in the Punjab on a paying basis. The prize is open to all, irrespective of caste, creed or nationality, and Government servants are also eligible for competition. The applicants should prove that some part of their discovery, invention, etc., is the result of work done after the prize was founded in 1925. The Managing Committee reserves to itself the right of withholding or postponing the prize, if no satisfactory achievement is reported to it. All entries in competition for the next award should reach the Director of Agriculture, Punjab, Lahore, on or before the 31st December, 1935.

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AGRICULTURAL RESEARCH COUNCIL (ENGLAND)

Change in Secretaryship.

With the approval of the Lord President and after consultation with the President of the Royal Society, the Agricultural Research Council have appointed Dr. E. J. Butler, C.M.G., C.I.E., D.Sc., M.B., F.R.S., Director of the Imperial Mycological Institute, to succeed Sir William Dampier as Secretary.

Dr. Butler was educated at Queen's (now University) College, Cork, where he was senior scholar, and at the Royal University of Ireland, where he graduated M. B. with Honours in 1898. He visited Paris, Antibes, and Freiburg with a Travelling Fellowship in Botany (1851 Exhibition). In 1901 Dr. Butler was appointed Cryptogamic Botanist to the Government of India, in 1905 Imperial Mycologist, India, and in 1919 Joint Director of the Agricultural Research Institute at Pusa, India. In 1920 he became Agricultural Adviser to the Government of India, and in the same year was appointed Director of the Imperial Bureau of Mycology (now the Imperial Mycological Institute) at Kew. He has been a member of the Agricultural Research Council for four years, a member of the Advisory Council, Department of Scientific and Industrial Research, and President of the British Mycological Society and of the Association of Economic Biologists.

Personal Notes, Appointments and Transfers, Meetings and Conferences, etc.

The Imperial Council of Agricultural Research

His Excellency the Governor-General in Council has been pleased, under the provisions contained in the last sentence of Rules I and 43 of the Rules and Regulations of the Imperial Council of Agricultural Research, to appoint the following as members of the Council and also as members of its Advisory Board, with effect from the dates noted against their names :—

Mr. G. K. DEVADHAR, M.A., C.I.E., Servants of India Society, Poona—23rd May, on which date he relinquished his previous membership of the Imperial Council of Agricultural Research and its Advisory Board.

Rao Bahadur M. VAIDYANATHAN, M.A., L.T., F.S.S., Statistician, Imperial Council of Agricultural Research—3rd July 1935.

Sardar DATAR SINGH, M.D.D., Proprietor of a Cattle and Dairy Farm at Montgomery—3rd July 1935.

Diwan Bahadur A. RAMASWAMI MUDALIAR, B.A., B.L., Madras—3rd July 1935.

Under Rule 1 (14) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Associated Chambers of Commerce of India have re-elected Sir JOSEPH KAY, Kt., as the representative of the European business community on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, on which date he relinquished his existing membership of the Council under the provisions of Rule 5 (3) of the said Rules and Regulations.

Under Rule 1 (15) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Federation of Indian Chambers of Commerce and Industry have elected Mr. CHUNILAL B. MEHTA as the representative of the Indian business community on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, in the vacancy caused by the relinquishment under Rule 5 (3) of the said Rules and Regulations, of his seat on the Council by Mr. WALCHAND HIRACHAND.

Under Rule 1 (37) of the Rules and Regulations of the Imperial Council of Agricultural Research, the Government of Assam have nominated Rai Sahib SRISH CHANDRA GHOSE, G.B.V.C., in charge of the office of the Superintendent, Civil Veterinary Department, on the Imperial Council of Agricultural Research, with effect from the 23rd May 1935, in the vacancy caused by the relinquishment under Rule 5 (3) of the said Rules and Regulations, of his seat on the Council by Mr. GURU PRASANNA SEN, G.B.V.C.

Rai Bahadur MALIK CHARAN DAS, I.S.S., Secretary, Imperial Council of Agricultural Research, has been permitted to retire from Government service with effect from the 16th July 1935.

Mr. N. C. MEHTA, I.C.S., has been appointed Secretary, Imperial Council of Agricultural Research, with effect from the forenoon of the 12th August 1935.

Col. A. OLVER, C.B., C.M.G., F.R.C.V.S., Animal Husbandry Expert, Imperial Council of Agricultural Research, has been granted leave on average pay, *ex*-India for four months, with effect from the 19th August 1935, with permission to prefix Sunday, the 18th August 1935.

Mr. F. WARE, F.R.C.V.S., I.V.S., Director, Imperial Institute of Veterinary Research, Muktesar, has been appointed, with effect from the 19th August 1935, to officiate as Animal Husbandry Expert, Imperial Council of Agricultural Research, *vice* Col. OLVER, granted leave.

The Indian Central Cotton Committee

Rao Bahadur D. ANANDA RAO, B.Sc. (Edin.), Director of Agriculture, Madras, has been nominated by the Government of Madras to be a member of the Indian Central Cotton Committee, as the representative of the Madras Agricultural Department, *vice* Mr. S. V. RAMAMURTY, I.C.S., resigned.

Mr. A. A. SARANTIDES has been nominated by the Bombay Chamber of Commerce to be a member of the Indian Central Cotton Committee, Bombay, *vice* Mr. M. DURUTTI, resigned.

The Indian Lac Cess Committee

In accordance with rule 4 of the Indian Lac Cess Rules the following members of the Indian Lac Cess Committee, whose term of office expired on the 31st July 1935, have been renominated by their respective Governments and constituency as members of the Indian Lac Cess Committee with effect from the 1st August 1935 :—

(1) Mr. J. L. MERRIMAN, I.C.S., nominated by the Government of Bihar and Orissa.

(2) Pandit RAMNATH BHADUPOTEY, nominated by the Government of Central Provinces.

(3) Mr. E. H. MARSHALL, nominated by the Bengal Chamber of Commerce.

The Imperial Institute of Agricultural Research

Mr. M. W. SAYER, B.A., Dip. Agri. (Cantab.), I.A.S., Officiating Imperial Agriculturist and Joint Director, Imperial Institute of Agricultural Research, Pusa, has been granted leave on average pay out of India for 3 months and 18 days with effect from the 13th June 1935, with permission to affix to it the Puja holidays and a Sunday from the 1st to the 13th October 1935.

Rao Bahadur B. VISWANATH, F.I.C., F.C.S., Imperial Agricultural Chemist, has been appointed, with effect from the 13th June 1935, to officiate as Joint Director, Imperial Institute of Agricultural Research, in addition to his own duties.

Mr. ARJUN SINGH MAN, L. Ag., Assistant Agriculturist, has been appointed to hold charge, in addition to his own duties, of the current duties of the post of Imperial Agriculturist, with effect from the 13th June 1935, *vice* Mr. M. W. SAYER.

The Imperial Institute of Veterinary Research

The services of Mr. F. WARE, F.R.C.V.S., I.V.S., Director, Imperial Institute of Veterinary Research, Muktesar, have been placed at the disposal of the Imperial Council of Agricultural Research, for appointment as Animal Husbandry Expert, with effect from the 13th August 1935.

Mr. J. R. HADDOW, B.Sc., M.R.C.V.S., D.V.S.M., I.V.S., Veterinary Research Officer, in charge of the Serological Section at the Imperial Institute of Veterinary Research, Muktesar, has been appointed to officiate as Director of the Institute in addition to his own duties, with effect from the 13th August 1935, *vice* Mr. F. WARE.

Mr. M. Y. MANGRULKAR, M.Sc., M.R.C.V.S., D.T.V.M. (Edin.), Assistant Director of Veterinary Services, Central Provinces, has been appointed Assistant Pathologist, Imperial Institute of Veterinary Research, Muktesar, with effect from the 6th July 1935, until further orders.

Madras

Mr. M. C. CHERIYAN, B.A., B.Sc. (Edin.), D.I.C. (London), Lecturer in Entomology, Agricultural College, Coimbatore, has been appointed to Category 5 of Class I of the Madras Agricultural Service and to officiate as Government Entomologist, Coimbatore, with effect from the 20th July 1935 or date of taking charge, *vice* Dr. T. V. RAMAKRISHNA AYYAR retiring from Government service.

Mr. P. N. KRISHNA AYYAR, B.A., Assistant Lecturer in Entomology, Agricultural College, Coimbatore, has been appointed to Category 7 of Class I of the Madras Agricultural Service and to officiate as Lecturer in Entomology, Agricultural College, Coimbatore, with effect from the 20th July 1935 or date of taking charge, *vice* Mr. M. C. CHERIYAN.

Mr. S. RAMACHANDRA AYYAR, Assistant, Entomology Section, Third Grade, has been appointed a member of the Madras Agricultural Service in Category 7, (Entomology Branch) of Class I, and to officiate as Assistant Entomologist with effect from the date of taking charge.

Mr. R. SWAMI RAO, L.Ag., Assistant Director of Agriculture, Kurnool, has been granted leave on average pay without medical certificate for one month and fifteen days from date of relief.

Mr. T. S. RAMASUBBRAHMANYA AYYAR, Permanent Assistant in Chemistry, I Grade and Officiating Assistant Agricultural Chemist, Coimbatore, has been appointed a full member of the service in Category 7 of Class I of the Madras Agricultural Service with effect from the 14th May 1935, *vice* Mr. K. S. VISWANATHA AYYAR, retired.

Mr. B. M. LAKSHMIPATHI MUDALIYAR, Estate Mechanical Engineer, Agricultural College, Coimbatore, has been appointed full member in Category 2, Class II, of the Madras Agricultural Service, with effect from the 15th June 1932.

Mr. K. KAILASAM AYYAR, G.B.V.C., Superintendent, Serum Institute, Madras, has been appointed to be Acting Principal, Madras Veterinary College, *vice* Mr. T. J. HURLEY, on other duty.

Mr. R. NARASINGA RAO, G.B.V.C., District Veterinary Officer, Madras, has been appointed to be Superintendent, Serum Institute, Madras, *vice* Mr. K. KAILASAM AYYAR, on other duty.

Mr. L. KUMARASWAMI, Veterinary Assistant Surgeon in the Selection Grade, has been appointed to Category 4 of Class I of the Madras Veterinary Service and posted as Acting District Veterinary Officer, Madras, *vice* Mr R. NARASINGA RAO, on other duty.

Mr. W. J. D'COSTA, G.M.V.C., District Veterinary Officer, Trichinopoly, has been granted leave on average pay for three months and seventeen days and on half average pay for one year eight months and six days in continuation thereof from the 1st July 1935, preparatory to retirement.

Mr. R. SWAMINATHAN, Acting District Veterinary Officer, Bezwada, has been appointed as Acting District Veterinary Officer, Trichinopoly, *vice* Mr. W. J. D'COSTA, granted leave preparatory to retirement.

Mr. C. VENKATARATNAM CHETTI, G.M.V.C., District Veterinary Officer, has been appointed, on return from leave, as District Veterinary Officer, Bezwada.

Bombay

Mr. L. S. S. KUMAR, M.Sc. (Lond.), A.R.C.S., D.I.C., has been confirmed in the post of Economic Botanist to Government in Class I of the Bombay Agricultural Service.

Mr. K. R. S. AIYAR, Lecturer at the Bombay Veterinary College, has been appointed as Assistant Professor at the College with effect from 4th September 1935, *vice* Mr. K. B. NAIR, proceeding on leave.

Bengal

Mr. A. R. MALIK, M.A., B.Sc. (Edin.), Deputy Director of Agriculture, Northern Circle, has been appointed to be Senior Marketing Officer, Bengal, with effect from the 7th February 1935.

Rai Sahib TARA NATH RAY, Inspector of Agricultural Schools, has been appointed to act as Deputy Director of Agriculture, Northern Circle, in the Bengal Higher Agricultural Service, with effect from the 7th February 1935, until further orders, *vice* Mr. A. R. MALIK, appointed to be Senior Marketing Officer.

Mr. P. K. BISWAS, District Agricultural Officer, has been appointed to act as Inspector of Agricultural Schools in the Bengal Lower Agricultural Service, with effect from the 7th February 1935, until further orders, *vice* Rai Sahib TARA NATH RAY.

Punjab

Khan Bahadur M. FATEH-UD-DIN, M.B.E., B.A., M.R.A.S., A.R.H.S., I.A.S., Deputy Director of Agriculture, Jullundur, has been granted leave on average pay *ex*-India for eight months, with effect from the 1st July 1935.

Mr. HAMID GHULAM SADIK, B.A. (Oxon.), Extra Assistant Director of Agriculture, Jullundur, has been appointed in charge of the duties of Deputy Director of Agriculture, Jullundur, with effect from the 1st July 1935, *vice* Khan Bahadur M. FATEH-UD-DIN, M.B.E., on leave.

Mr. HARNAM SINGH, Agricultural Assistant (A Class), Oil-seed Research Sub-station, Ludhiana, has been appointed Officiating Extra Assistant Director of Agriculture, Jullundur, with effect from the 1st July 1935, *vice* Mr. HAMID GHULAM SADIK.

Khan Sahib AGHA YUSAF ALI KHAN, in charge of the duties of Deputy Director of Agriculture, Montgomery, has been appointed Deputy Director of Agriculture, Montgomery, in the Punjab Agricultural Service, Class I, with effect from the 1st April 1935, against the post sanctioned for the Multan Circle.

Mr. CHARAN SINGH, Extra Assistant Director of Agriculture, Hansi, has been appointed in charge of the duties of Deputy Director of Agriculture, Multan, with effect from the 1st May 1935, in the special temporary post created against the leave vacancy of Sardar Sahib S. S. KHARAK SINGH, I.A.S., and vacated by Khan Sahib AGHA YUSAF ALI KHAN.

Mr. GURDIAL SINGH, Officiating Extra Assistant Director of Agriculture, Jullundur, has been transferred to Multan with effect from the 15th June 1935 subject to the lien of Khan Sahib AGHA YUSAF ALI KHAN.

Mr. AMANAT KHAN, B.Sc. Agri. (Edin.), resumed charge of his appointment as Extra Assistant Director of Agriculture, Lyallpur, on the 20th July 1935, on reversion from the temporary post of Deputy Director of Agriculture, Lyallpur.

Mr. JASWANT SINGH, B.A., Extra Assistant Conservator of Forests, has been appointed Extra Assistant Director of Agriculture (Fruit), Lyallpur, with effect from the 11th July 1935, on his services being placed at the disposal of the Agricultural Department and relieving Mr. DALIP SINGH who reverts to the Forest Department.

Mr. LAL SINGH, B. Sc. (Hons.), M.Sc. (Calif.), on return from leave, resumed charge of the post of Fruit Specialist, Lyallpur, on the forenoon of 18th October 1934, relieving S. BAL SINGH who reverted to the temporary post of Assistant Fruit Specialist, Lyallpur.

Lala TEHL RAM, Agricultural Assistant (A Class), Manager, Agricultural Farm, Rohtak, has been appointed Agriculturist, Dry Farming Research Scheme, Rohtak, in the Punjab Agricultural Service, with effect from the 1st July 1935, in a temporary post created for the Dry Farming Research Scheme and on probation for one year.

Mr. SUKH DAYAL, M.Sc. (Pb.), Agricultural Assistant (A Class), Chemical Section, Punjab Agricultural College, Lyallpur, has been appointed Soil Physicist, Dry Farming Research Scheme, Rohtak, in the Punjab Agricultural Service, with effect from the 1st July 1935, in a temporary post created for the Dry Farming Research Scheme, and on probation for one year.

Mr. H. R. SAINI, M.Sc., B.Sc. (Edin.), Fodder Specialist, Sirsa, has been granted leave on average pay for three months, with effect from the 16th July 1935.

Mr. J. S. GULERI, M.A., LL.B., F.E.S., on return from leave, resumed charge of the post of Assistant Professor of Agricultural Economics, Punjab Agricultural College, Lyallpur, on the forenoon of the 1st July 1935.

Mr. L. W. SMITH, Superintendent, Government Cattle Farm, Hissar, has been granted leave on average pay for 6 months (*ex*-India) with effect from 4th April 1935.

Mr. W. S. READ, P.V.S., Assistant Superintendent (Fodder), Government Cattle Farm, Hissar, has been appointed Officiating Superintendent, Government Cattle Farm, Hissar, with effect from the 4th April 1935, *vice* Mr. L. W. SMITH, granted leave.

Mr. MOHAMMAD JAN, P.V.S., Deputy Superintendent (Stock), Government Cattle Farm, Hissar, has been appointed Officiating Assistant Superintendent (Fodder), Government Cattle Farm, Hissar, with effect from the 4th April 1935, *vice* Mr. W. S. READ, appointed Superintendent, Government Cattle Farm, Hissar.

Mr. BALDEO SINGH, G.P.V.C., P.V.S., Deputy Superintendent, Civil Veterinary Department, Hissar, has been appointed Officiating Deputy Superintendent (Stock), Government Cattle Farm, Hissar, with effect from 4th April 1935, *vice* Sh. MOHAMMAD JAN, appointed Officiating Assistant Superintendent (Fodder) Government Cattle Farm, Hissar.

Mr. JAINTI RAM, P.V.S., Temporary Deputy Superintendent, Civil Veterinary Department, Gurgaon, has been appointed to carry on the duties of the Deputy Superintendent, Civil Veterinary Department, Hissar, in addition to his own duties, without extra remuneration, with effect from the 4th April 1935, *vice* Ch. BALDEO SINGH.

Mr. QAMAR-UD-DUN BUTT, P.V.S., Deputy Superintendent, Civil Veterinary Department, Rawalpindi, retired from the Government service with effect from the 1st July 1935

Burma

Mr. BWIN GYI, Veterinary Inspector, has been appointed as Veterinary Superintendent, on probation for one year, with effect from the date on which he assumes charge of his new duties.

Bihar and Orissa

Mr. PROMODE RANJAN HANSDAH ACHARJEE has been appointed to be Junior Marketing Officer, Bihar and Orissa Marketing Scheme, with effect from 1st June 1935.

Mr. MANILAL HARINARAYAN JANI has been appointed to be Junior Marketing Officer, Bihar and Orissa Marketing Scheme, with effect from 28th May 1935.

Mr. PREM CHANDRA VARMA has been appointed to be Junior Marketing Officer, Bihar and Orissa Marketing Scheme, with effect from 24th May 1935.

Central Provinces

OBITUARY NOTICE

The Governor in Council and the Hon'ble the Ministers have heard with great regret of the death of Major R. F. Stirling, Director of Veterinary Services in the Central Provinces. Major Stirling was attached to the British Expeditionary Force on the Western Front during the Great War. On the conclusion of hostilities he entered the service of the Central Provinces Government on the 8th April 1920, as Second Superintendent, Civil Veterinary Department, and was placed in charge of the Department on the 22nd February 1928. The contributions which he made to the development of preventive methods of inoculation for the diseases of cattle earned him a reputation extending beyond the limits of the Province, and his professional skill, allied to great enthusiasm for his work, made his seven years of office notable in the history of the Department. His loss will be severely felt.

Assam

Babu BINODE BEHARI DAS, B.Ag., Superintendent of Agriculture on special duty, has been allowed leave on average pay for four months with effect from the 1st June 1935, or from any subsequent date on which he may avail himself of it.

Rai Sahib SRISH CHANDRA GHOSH, G.B.V.C., Veterinary Inspector, has been appointed temporarily to be Deputy Superintendent of the Civil Veterinary Department, Assam, in the Assam Veterinary Service, Class II, and has been placed temporarily in charge of the Civil Veterinary Department, Assam, with effect from the 1st July 1935, until further orders.

NEW BOOKS

On Agriculture and Allied Subjects.

Preservation of Farm Animals. By H. Gehlot, Dip. Agri. (Wye), M. R. A. S. E. (Lond.). (Jodhpur : Udaya Art Printing Press.) Price Rs. 2.

The Path of the Gopatis. By Zilpha Carruthers. Illustrated by Jezzie Gillespie. (National Dairy Council, 910 South Michigan Avenue, Chicago).

Studies on the Ecology of Coffee Plantations in East Africa. 1 : The Climate and Eco-Climates of Coffee Plantations. By Kirkpatrick, T. W. Imp. 8vo. Pp. 66+26 plates. (Amani : East African Agricultural Research Station ; London : The Crown Agents for the Colonies, 1935.) 5*s*.

Variations in the Composition of Milk. By Ministry of Agriculture and Fisheries. Bulletin No. 16. Roy. 8vo. Pp. v+22+3 plates. (London : H. M. Stationery Office, 1935). 6*d*. net.

Experiments in Table Poultry Production. By Ministry of Agriculture and Fisheries. Bulletin No. 91. Roy. 8vo. Pp. v+59. (London : H. M. Stationery Office, 1935). 1*s*. net.

Investigations into the Problem of Milk with a Low Content of Solids-not-Fat. By M. N. Nicholson, B.Sc., and G. E Lesser, N. D. A., N. D. D. Bulletin No. XLVI. (University of Reading, Department of Agriculture. 1934).

The Poultry-Keeper's Text-book. By E. T. Brown, F. L. S. 2nd Edition. Pp. 320, with 150 figs. (London : Ward, Lock & Co., Ltd. 1934). Price 6*s*.

List of Publications of the Imperial Agricultural Bureaux (1934-35.)

I. Obtainable from the Imperial Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts

[*All publications are sent post free from the Imperial Bureau of Soil Science*]

1. *Technical Communications*

		Price
29.	Soil, Vegetation and Climate. By G. V. Jacks. Pp. 43 . . .	2*s.*
30.	The Determination of Exchangeable Bases in Soils. Pp. 35 . .	2*s.*
31.	Soil Deficiencies and Plant Diseases. By G. V. Jacks and H. Scherbatoff. Pp. 48	2*s.*
32.	Tea Soils. By Harold H. Mann. Pp. 66	2*s.*

2. *Publications relating to Soils and Fertilizers*

Monthly lists, with brief abstracts of all current papers and pamphlets indexed by the Bureau. The papers are classified by subjects, according to the Decimal Classification, and the lists are duplicated in a convenient form for cutting out the separate entries and filing them in an index, if required.

Price 10*s.* per annum, post free, separate copies, each . . . . . 1*s.*

3. *Monthly Letters*

These consist of short accounts of outstanding pieces of recent research and of matters of general interest connected with the Bureau's activities. They are sent free, within the British Empire, to all recipients of publications relating to Soils and Fertilizers. Outside the Empire, or when sold separately, a charge of 4*s.* per annum is made.

Separate copies, each . . . . 6*d.*

4. *Publications on Soil Science issued from the Empire Overseas*

Bibliographical lists, 1933, 1934, each . . . . . . 1*s.*

5. *Recent Developments in Soil Analysis*

A quarterly supplement to 'Publications relating to Soils and Fertilizers,' containing full descriptions of recently published analytical methods, each. 6*d.*

Price

6. *Annual Reports*

Nos. 5 and 6, each . . . . 6*d*.

7. *Lists of Reprints Available on Loan*

No. 1 . . . . 1*s*. 6*d*.
Subsequent issues, each . . . . 6*d*.

8. *Miscellaneous Publications*

Bibliography of publications relating to Coffee Soils and Fertilizers (1934). Pp. 55 . . . . 2*s*.

9. *Bibliography of Soil Science, Fertilizers and General Agronomy, 1931-34*

A complete reference book to the recent literature of soil and allied sciences. The bibliography contains over 6,000 classified references, a comprehensive subject index, lists of some 4,000 authors and 800 journals and periodicals, and a concise account of the system of classification used.

Crown octavo. Pp. XXXI + 473. Bound in cloth . . . . . 25*s*.

Special Publication

The Katamorphism of Igneous Rocks under Humid Tropical Conditions. (By the late Professor Sir John Burchmore Harrison, C. M. G. Published on behalf of the British Association and Demerara Proprietors Ltd., this monograph gives a detailed account of the author's work, during thirty-seven years in British Guina, on the processes of laterization.)

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Inclusive annual subscription	15*s*.
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15. Grassland and Forage Crops in Thuringia, Czechoslovakia and Hungary. By R. O. Whyte and Collaborators. August, 1934 . . . 3*s* 6*d*.

16. The Theoretical Significance of Vernalization. By N. A. Maximov. December, 1934 . . . . 2*s*. 6*d*.

IV. OBTAINABLE FROM THE IMPERIAL BUREAU OF FRUIT PRODUCTION, EAST MALLING RESEARCH STATION, EAST MALLING, KENT

Journal

Horticultural Abstracts.—A quarterly abstract publication of current horticultural literature. Vol. IV. Annual subscription . . . . 15*s*.

Single copy . . . . 4*s*.

Technical Communication

5. The 'Degeneration' of the Strawberry, 1934. D. Akenhead, R. V. Harris, G. H. Berkeley, A. M. Massee . . . . 2*s*.

Occasional Paper

Annotated Bibliography on Bitter-pit, 1934 . . . . 1*s*. 6*d*.

Other Publications

Index to Vols. I–X of the Journal of Pomology and Horticultural Science, 1933. Compiled by Bureau. Published by the Editors of the Journal of Pomology and Horticultural Science. Available from the Bureau . . 5*s*.

V. OBTAINABLE FROM THE IMPERIAL BUREAU OF AGRICULTURAL PARASITOLOGY, INSTITUTE OF AGRICULTURAL PARASITOLOGY, WINCHES FARM DRIVE, HATFIELD ROAD, ST. ALBANS, HERTS

Bibliography of Helminthology: for the year 1932 (including subject index to titles), 97 pp. Library Edition, bound in cloth 10*s*. 6*d*

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Price

Bibliography of Helminthology: for the year 1933 (including subject index to titles). Library Edition, bound in cloth . . . . . . 10*s*. 6*d*.

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***Helminthological Abstracts*.—Issued in six parts annually by the *Journal of Helminthology*: incorporates abstracts prepared by the Bureau of original papers on applied helminthology.**

Subscription price for Vol. III (1934), post free . . . . . . 30*s*. net

The Bearing of the Physiology of Parasitic Nematodes on their Treatment and Control (post free) . . . . 3*s*.

VI. OBTAINABLE FROM THE IMPERIAL BUREAU OF ANIMAL GENETICS, INSTITUTE OF ANIMAL GENETICS, UNIVERSITY OF EDINBURGH, KING'S BUILDINGS, WEST MAIN ROAD, EDINBURGH

Journal

Animal Breeding Abstracts (quarterly) commencing April 1933. Annual subscription . . . . 15*s*.

Occasional Papers

Bibliography on the works of J. C. Ewart (free to subscribers of *Ani Breeding Abstracts, Vol. I*), 1934 . . . . 6*d*

Animal Breeding in the British Empire. A Survey of Research and Experiment, 1934 . . . . 2*s*.

VII. OBTAINABLE FROM THE IMPERIAL BUREAU OF ANIMAL HEALTH, VETERINARY RESEARCH LABORATORY, NEW HAW, WEYBRIDGE, SURREY

Abstracting Journal

The Veterinary Bulletin :
Annual subscription . . . . 40*s*.

Indexing Publication

Index Veterinarius: Four issues a year. Annual subscription (postage paid) 80*s*.

VIII. OBTAINABLE FROM THE IMPERIAL BUREAU OF ANIMAL NUTRITION, ROWETT RESEARCH INSTITUTE, BUCKSBURN, ABERDEEN

Journal

Nutrition Abstracts and Reviews.—(Issued under the direction of the Imperial Agricultural Bureaux Council, the Medical Research Council and the Reid Library) Subscription per volume of 4 numbers . . . . . . 21*s*.

Per single number . . . . 5*s*. 6*d*.

Occasional Papers

***Technical Communication*:**

5. Recent Research in Poultry Nutrition, by A. R. G. Emslie . . . . 1*s*.

X

List of Agricultural Publications in India from 1st February to 31st July 1935.

Title	Author	Where published
GENERAL AGRICULTURE		
Agriculture and Livestock in India, Vol. V, parts 2, 3 and 4. Annual subscription Rs. 6 or 9*s*. 9*d*. (A bi-monthly Journal of Agriculture and Animal Husbandry for the general reader interested in agriculture or livestock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
The Madras Agricultural Journal (Monthly). Annual subscription Rs. 4.	K. Ramiah (Editor). Published by the M. A. S. Union, Agricultural and Research Institute, Coimbatore.	The Secretary, M. A. S. Union, Agricultural College, Lawley Road, P. O.
The Journal of the Trichinopoly District Agricultural Association.—(English and Tamil). Quarterly. Annual subscription Re. 1-8-0 for non-members, free for members.	Issued by the Trichinopoly District Agricultural Association, Teppakulam Post.	The Secretary, The Trichinopoly District Agricultural Association, Teppakulam Post.
The Journal of the Mysore Agricultural and Experimental Union.—(English). Quarterly. Price, As. 12 per copy.	B. Narasimha Iyengar (Chief Editor).	The Secretary, The Mysore Agricultural and Experimental Union, Seshadri Road, Bangalore.
The Journal of the Mysore Agricultural and Experimental Union.—(Kannada). Monthly. Price As. 4 per copy.	N. Venkatasubbaiya .	Ditto.
The Poona Agricultural College Magazine.—(Quarterly). Annual subscription Rs. 2-8-0.	V. G. Deshpande and S. M. Rao (Editor).	The Editor, Poona Agricultural College, Magazine, Poona.
Shetki Shetkhari (Marathi, Monthly). Annual subscription Re. 1-8-0.	Vasudev Ganesh Pande.	The Editor, Shetki Shetkari, Agricultural College, Poona.
The Planters' Journal and Agriculturist (Fortnightly). Annual subscription Rs. 10 or 16*s*.	Theo. H. Thorne (Editor).	The Manager, The Planter's Journal and Agriculturist, 13, Ezra Mansions, Calcutta.

Title	Author	Where published
GENERAL AGRICULTURE—*contd*.		
Krishi-Sampad (Bengali, Monthly). Annual subsciiption Rs. 3.	N. K. Ghosh (Editor) .	Manager, Krishi Sampada Office Dacca.
Mufidul Mazarain (Urdu) . .	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, U. P., Allahabad.
Kisan Upkarak (Hindi) . .	Ditto .	Ditto.
The Allahabad Farmer (Bi-monthly). Annual subscription in India Rs. 2.	B. M. Pugh (Editor). Published by the Agricultural Institute, Allahabad.	The Allahabad Agricultural Institute, United Provinces (American Presbyterian Mission), Allahabad.
Seasonal Notes.—(Price, As. 4 per copy).	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
The Nagpur Agricultural College Magazine (Quarterly). Annual subscription Rs. 3.	Published by P. D. Nair, Agricultural College, Nagpur.	The Editor, the Nagpur Agricultural College Magazine, College of Agriculture, Nagpur.
Kisan (Hindi—Quarterly) Annual subscription Rs. 2 or As. 8 per copy.	Issued by the Agricultural Association, Bihar and Orissa.	B. N. Sarcar, Esq., Senior Marketing Officer and Editor, " Kisan ", Patna.
The Production of Cigarette Tobacco by Flue-curing (Pusa Bulletin No. 187, revised 1935) Price Re. 1 or 1*s*. 9*d*.	F. J. F. Shaw and Kashi Ram.	Manager of Publications, Delhi,
Reports on the work of the Agricultural Stations in the Madras Presidency for 1933-34.	Issued by the Department of Agriculture, Madras.	Superintendent, Government Press, Madras.
Villagers' Calendar for 1935-36 (Tamil, Telugu and Kanarese). Price Anna 1 each.	Ditto . .	Ditto.
Electricity in Agriculture . .	Issued by the Madras Government, Electricity Department.	Ditto.
Electric Power for Agricultural Uses.	Ditto .	Ditto.

Title	Author	Where published
GENERAL AGRICULTURE—*contd*.		
A Bund forming Implement. (Tamil, Kanarese and Malayalam) Leaflet No. 61 of the Department of Agriculture, Madras.	N. G. Charley . .	Superintendent, Government Press, Madras.
Cotton Leaflet No. 66 of the Department of Agriculture, Madras (English, Tamil and Kanarese).	A. C. Edmonds . .	Ditto.
How to send specimens for examination. (Reprinted). Leaflet No. 21 of the Department of Agriculture, Madras.	S. R. Srinivasa Iyengar	Ditto.
The Economic Condition of the Ryot in the Vizagapatam District and how to improve it. Bulletin No. 46 of the Department of Agriculture, Madras. Price, As. 6.	Jogi Raju . . .	Ditto.
Some practical hints on Beekeeping. Bulletin No. 37 of the Department of Agriculture, Madras. Price Re. 1.	S. Ramachandra Iyer .	Ditto.
Tokra (*Ovabanche* sp.) A pest on tobacco.	T. Budhavidheya Rao Naidu.	Ditto.
Annual Report of the Department of Agriculture, Bombay, for 1933-34. Price As. 9.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
Annual Report of the Department of Agriculture in Sind for the year 1933-34.	Issued by the Chief Agricultural Officer, Sind.	Ditto.
Note on Cotton Cultivation (revised). Bulletin No. 2 of 1932 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
Report on the Administration of the Department of Agriculture, United Provinces, for the year ending June 30, 1934.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.

Title	Author	Where published

GENERAL AGRICULTURE—*contd.*

Title	Author	Where published
A Summary of the Important results arrived at or indicated by the Agricultural Stations in the United Provinces during the year 1933-34.	Issued by the Department of Agriculture, United Provinces,	Government Printing and Stationery, United Provinces, Allahabad.
Methods of Improvement in Crops. Bulletin No. 1, General Series of the Department of Agriculture, United Provinces.	R. L. Sethi, B. L. Sethi and T. R. Mehta.	Ditto.
Early Sowing of Sugarcane. (Urdu) Leaflet No. 6 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Ditto.
Utilization of Water Hyacinth as Manure. Leaflet No. 24 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Field rats in the United Provinces (Hindi), Leaflet No. 6 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Annual Report of the Department of Agriculture, Punjab for the year ending 30th June 1934. Price Re. 1-4-0.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Prospectus of the Punjab Agricultural College, Lyallpur.	Ditto . .	Ditto.
Instructions to Silk Worm Rearer. Leaflet No. 125 of the Department of Agriculture, Punjab.	Ditto . .	Ditto.
A New Early-maturing Strain of Punjab-American 43 F. Leaflet No. 126 of the Department of Agriculture, Punjab.	Ditto . .	Ditto.
Rich Manure. The Gold of Farmers, Nos. 1 and 2 (Revised). (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
A short note on field rats and how to control them (Revised). (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Cultivation of substitute Crop for Jute (Bengali and Assamese). Bulletin No. 6 of 1935 of the Department of Agriculture, Assam.	Issued by the Department of Agriculture, Assam.	Assam Government Press, Shillong.
Annual Report on the Department of Agriculture, North-West Frontier Province for 1933-34.	Issued by the Government of the North-West Frontier Province, Peshawar.	Manager, Government Stationery and Printing, North-West Frontier Province, Peshawar.
Summary Proceedings of the Twenty-ninth meeting of the Indian Central Cotton Committee, Bombay, held on the 28th and 29th August 1934. Price Re. 1.	Issued by the Publicity Officer, Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
Summary Proceedings of the Thirtieth Meeting of the Indian Central Cotton Committee, Bombay, held on the 4th and 5th February 1935. Price Re. 1.	Ditto.	Ditto.
Annual Report of the Department of Agriculture, Gwalior Government for the year 1932-33.	Issued by the Department of Agriculture, Gwalior Government.	Alijah Durbar Press, Gwalior.
A Summary of the Present Activities of the Department of Agriculture, Gwalior Government Bulletin No. 15.	Ditto . .	Ditto.
Annual Report of the Coffee Scientific Officer, 1934-35. Price As. 4.	W. Wilson Mayne .	Superintendent, Government Press, Bangalore.
Annual Administration Report of the Department of Agriculture, Mysore State for 1933-34. Price Re. 1-8.	Issued by the Department of Agriculture, Mysore.	Ditto.

Title	Author	Where published
GENERAL AGRICULTURE—*concld.*		
Report on the Administration of the Department of Agriculture and Fisheries, Travancore State, for the year 1933-34.	Issued by the Director of Agriculture and Fisheries, Travancore.	Government Press, Travancore.
T. E. B. No. 1, Paddy Seeds evolved by the Botanist for the Alkaline Lands in South Travancore.	N. K. B. Kurup . .	Ditto.
Typha Spp. (Tamil Champa). A Note in English.	Ditto . .	Ditto.
Manuring of Coconut Palms .	M. K. Narayana Pillai .	Ditto.
Report on the Administration of the Agricultural Department, Cochin State, for the year 1933-34.	Issued by the Superintendent of Agriculture, Trichur.	Cochin Government Press, Ernakulam.
Marketing Survey. (Malayalam) .	Ditto . .	Ditto.
Seeds and Seed Selection (Malayalam).	Ditto . .	Ditto.
Bombay Cotton Annual. No. 14. Price Rs. 2.	Issued under the authority of the East India Cotton Association, Ltd., Bombay.	Published by the Manager, Clearing House, E.I.C.A. Bombay.
AGRICULTURAL ECONOMICS		
Family Budgets, 1932-33, of Four Tenant-cultivators in the Lyallpur District. The Board of Economic Enquiry, Punjab. Publication No. 40. Price, As. 6.	Sardar Kartar Singh . .	Published by C. & M. Gazette, Ltd., Lahore
An Economic Survey of Gajja Chak, a village in the Gujranwala District of the Punjab. Board of Economic Enquiry, Punjab. Rural Section Publication No. 31. Price Rs. 3.	Inquiry conducted by Anchal Dass under the supervision of C. E. Strickland.	Ditto.

AGRICULTURAL STATISTICS

Title	Author	Where published
Estimates of Area and Yield of Principal Crops in India, 1933-34.	Issued by the Department of Commercial Intelligence and Statistics, India, Calcutta.	Manager of Publications, Delhi.
Agricultural Statistics of India 1931-32, Vol. II.	Ditto .	Ditto.
Quinquennial Report on the Average Yield per acre of Principal Crops in India for the period ending 1931-32. Price Re. 1-14 or 3*s*. 3*d*.	Ditto .	Ditto.
Season and Crop Report of the Madras Presidency, 1933-34.	Issued by the Board of Revenue, Land Revenue and Settlement, Madras.	Superintendent, Government Press, Madras.
Annual Season and Crop Report of the Bombay Presidency for the year 1933-34. Price As. 7.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
Season and Crop Report of Bengal for 1934-35.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
Monthly and Annual Rainfall Tables in the Province of Bengal for 1934.	Ditto .	Ditto.
Season and Crop Report of the Department of Agriculture, Burma, 1933-34	Issued by the Commissioner of Settlements and Land Records, Burma.	Superintendent, Government Printing and Stationery, Burma, Rangoon.
Season and Crop Report, Bihar and Orissa, 1934-35.	Issued by the Department of Agriculture, Bihar and Orissa.	Superintendent, Government Printing, Bihar and Orissa, Gulzarbagh.

Title	Author	Where published
SUGAR RESEARCH		
The Open-Pan System of White Sugar Manufacture. (2nd edition, 1935). Scientific Monograph No. 3 of the Imperial Council of Agricultural Research. Price Rs. 3-2-0 or 5*s*. 6*d*.	R. C. Srivastava . .	Manager of Publications, Delhi.
The Planting of Sugarcane. Bulletin No. 38 of the Department of Agriculture, Madras. Price, As. 4.	A. C. Edmonds. . .	Government Press, Madras.
Good *Gur* and Method of its manufacture (Urdu) Leaflet No. 20 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Sugarcane in Burma with a Note on the possibility of White Sugar Manufacture in the Pyinmana area. Agricultural Survey No. 19 of 1934	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
A Rough Survey of suitable Sugarcane areas in Kyaukse District.	Ditto .	Ditto.
Profits from new and ratoon canes (English and Hindi). Leaflet of the Department of Agriculture, Central Provinces.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
COTTON TECHNOLOGY		
Combing of good quality Indian Cotton. Technological Bulletins. Series A, No. 27. Price Re. 1.	R. P. Richardson and Nazir Ahmad.	Indian Central Cotton Committee, Bombay.
Effect of Storage prior to ginning on the Spinning Quality of Cotton. Technological Bulletins, Series B, No. 19. Price As. 8.	Nazir Ahmad . .	Ditto.

Title	Author	Where published
COTTON TECHNOLOGY—*contd.*		
Report on the staple length of the Indian Cotton Crop of 1934-35 season. Statistical Leaflet No. 1. Second Issue (1934-35). Price 1 Anna.	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
Spinning Test Report (No 559) on Samples of C. P. No. 1 Cotton, 1934-35. Technological Circular No. 158. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 560) on Samples of Berar Cotton, 1934-35 Technological Circular No. 159. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 561) on Samples of Khandesh Cotton, 1934-35. Technological Circular No. 160. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 566) on Samples of Khandesh Cotton, 1934-35. Technological Circular No. 161. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 567) on Samples of Moglai Cotton, 1934-35. Technological Circular No. 162. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 568) on Samples of Bengal Cotton, 1934-35. Technological Circular No. 163. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 570) on samples of Ujjain (Ujjain) Cotton, 1934-35. Technological Circular No. 164. Price As. 4.	Ditto	Ditto.
Spinning Test Report (No. 571) on Samples of Ujjain (Mandusar) Cotton, 1934-35. Technological Circular No. 165. Price As. 4.	Ditto	Ditto.

COTTON TECHNOLOGY—*contd.*

Title	Author	Where published
Spinning Test Report (No. 577) on Samples of Hubli Kumpta Cotton, 1934-35. Technological Circular No. 166. Price As. 4.	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
Technological Report on Gadag 1 (Dharwar-American), 1934-35. Technological Circular No. 167. Price As. 4	Ditto .	Ditto.
Spinning Test Report (No. 582) on Samples of Latur Cotton, 1934-35. Technological Circular No. 168. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 583) on Samples of Nanded Cotton, 1934-35. Technological Circular No. 169. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 584) on Samples of Muttia Cotton, 1934-35. Technological Circular No. 170. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 591) on Samples of Broach Cotton, 1934-35. Technological Circular No. 171. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 592) on Samples of Jagadia Cotton, 1934-35. Technological Circular No. 172. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 593) on Samples of Punjab American Cotton, 1934-35. Technological Circular No. 173. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 595) on Samples of Bailhongal Cotton, 1934-35. Technological Circular No. 174. Price As. 4.	Ditto .	Ditto.

Title	Author	Where published
COTTON TECHNOLOGY—*contd.*		
Spinning Test Report (No. 596) on Samples of Broach Cotton, 1934-35. Technological Circular No. 175. Price As. 4.	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
Spinning Test Report (No. 597) on Samples of Karunganni Cotton, 1934-35. Technological Circular No. 176. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 598) on Samples of Tiruppur Cambodia Cotton, 1934-35. Technological Circular No. 177. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 599) on Samples of Northern Cambodia Cotton, 1934-35. Technological Circular No. 178. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 600) on Samples of Farm Westerns Cotton, 1934-35. Technological Circular No. 179. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 602 on Samples of Miraj Cotton, 1934-35. Technological Circular No. 181. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 603) on Samples Nandyal Cotton, 1934-35. Technological Circular No. 182. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 604) on Samples of Surat Cotton, 1934-35. Technological Circular No. 183. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 606) on Samples of Tiruppur Cambodia Cotton, 1934-35. Technological Circular No. 184. Price As. 4.	Ditto .	Ditto.

Title	Author	Where published
COTTON TECHNOLOGY—*concld.*		
Spinning Test Report (No. 607) on Samples of African Busoga Cotton, 1934-35. Technological Circular No. 185. Price As. 4.	Issued by the Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.
Spinning Test Report (No. 608) on Samples of Kampala Cotton, 1934-35. Technological Circular No. 186. Price As. 4.	Ditto .	Ditto.
Spinning Test Report (No. 609) on Samples of Hubli Upland Cotton, 1934-35. Technological Circular No. 187. Price As. 4.	Ditto .	Ditto.
Technological Report on Punjab-American 4F, 1934-35. Technological Circular No. 188. Price As. 4.	Ditto .	Ditto.
FRUITS		
Report of the Committee on the Improvement in the Marketing of Fruit and Vegetables in the town of Bombay 1934. Price Re. 1.	Issued by the Committee appointed by the Government of Bombay.	Government Central Press, Bombay.
The Guava (Urdu). Bulletin No. 8 Fruit Series of the Department of Agriculture, United Provinces.	W. S. Smith . .	Government Printing and Stationery, U. P., Allahabad.
The Note on Pine Apple. Bulletin No. 9, Fruit Series of the Department of Agriculture, United Provinces	V. Sane . . .	Ditto.
Sundry papers on Fruit Development, Fruit Growers Organization and the necessity of improving the basis of marketing (Hindi). Bulletin No. 11, Fruit Series of the Department of Agriculture, United Provinces.	R. G. Allan . . .	Ditto.
A Study of the Marketing of Fruits at Calcutta.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh.

Title	Author	Where published

LAC

Title	Author	Where published
A Simple Method for the Forecast of Emergence of Lac Larvæ.	P. S. Negi . . .	The Indian Lac Research Institute, Namkum, Ranchi.
A Simple Method for the Forecast of Emergence of Lac Larvæ in Oriya.	Issued by the Indian Lac Research Institute, Namkum.	The Indian Lac Research Institute, Namkum, Ranchi.
Lac and the Indian Lac Research Institute.	Dorothy Norris, P. M. Glover and R. W. Aldis.	The Indian Lac Research Institute, Namkum, Ranchi.
Lac Cultivation and Shellac Industry.	P. M. Glover. . .	The Indian Lac Research Institute, Namkum, Ranchi.
The Alimentary Canal, its Appendages, Salivary glands and the Nervous System of the Adult Female Lac Insect., *Laccifer lacca* Kerr (Coccidæ).	P. S. Negi . . .	The Indian Lac Research Institute, Namkum, Ranchi.
The Developmental Stages of *Bracon tachardiæ* Cum (Hym).	P. M. Glover. . .	The Indian Lac Research Institute, Namkum, Ranchi.

AGRICULTURAL SCIENCE

GENERAL

Title	Author	Where published
The Indian Journal af Agricultural Science, Vol. V, parts 1, 2 & 3. Annual subscription Rs. 15 or 24s. (Original scientific work in the various branches of science applied to agriculture, formerly published in the Memoirs of the Imperial Department of Agriculture in India is now published in *the Indian Journal of Agricultural Science*.)	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.

Title	Author	Where published
BOTANY		
The Bombay Grasses. Scientific Monograph No. 5 of the Imperial Council of Agricultural Research. Price Rs. 20-12-0 or 32s. 6d.	E. J. Blatter and C. McCann. Illustrated by B. K. Bhide.	Manager of Publications, Delhi.
Scientific Report of the Rice Research Stations, Bihar and Orissa, Sabour for the year ending 31st March 1934.	Issued by the Department of Agriculture, Bihar and Orissa.	Superintendent, Government Printing, Bihar and Orissa, Gulzarbagh.
CHEMISTRY AND PHYSI[redacted]CAL CHEMISTRY		
Making of Pouderette from Night Soil (English). Leaflet No. 67 of the Department of Agriculture, Madras.	P. V. Ramiah . .	Government Press, Madras.
Report on investigation on a New and Simple Process for the Manufacture of Active Charcoal from Paddy husk and on the Manufacture of 'Cream Jaggery' using the Active Carbon. Bulletin No. 39 of the Department of Agriculture, Madras. Price As. 10	B. Viswanath . .	Ditto.
A Decennial Review of Biochemical Investigations on Soils carried out in the Central Provinces and Berar (Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
The Preparation of Bone-Char Manure. Leaflet No. 10.	Issued by the Director, Institute of Plant Industry, Indore.	The Director, Institute of Plant Industry and Agricultural Adviser to States in Central India and Rajputana, Indore.
The Making of Rain-Watered Compost Manure from Farm Wastes. (Revised). Leaflet No. 2.	Ditto . .	Ditto.
Use of Scientific Manures such as Oilcake, Fish Manure, Prawn Dust, etc. (Malayalam).	Issued by the Superintendent of Agriculture, Trichur.	Cochin Press, Ernakulam.

Title	Author	Where published
CHEMISTRY AND PHYSI[redacted]CAL CHEMISTRY—*contd.*		
Restoring the used up Nutritious Matters and retaining the fertility of the Soil (Malayalam).	Issued by the Superintendent of Agriculture, Trichur.	Cochin Press, Ernakulam.
Preparation of Cattle Manure and Composts (Malayalam).	Ditto . .	Ditto.
Studies on the Pectic Substances in Tea. Bulletin No. 6. Price Re. 1 for members and Rs. 2 for non-members.	Issued by the Secretary, United Planters' Association of Southern India.	The Secretary, United Planters' Association of Southern India, Glen View, Coonoor, Nilgiris.
The Nitrogen Distribution in Tea. Bulletin No. 7. Price Re. 1 for members and Rs. 2 for non-members.	Ditto.	Ditto.
The Aroma of Tea. Bulletin No. 8, Price Re. 1 for members and Rs. 2 for non-members.	Ditto . .	Ditto.
Night Soil Compost Manure. Leaflet of the Department of Agriculture, Travancore.	K. R. Narayana Iyer .	The Director of Agriculture and Fisheries, Travancore.
The Relation between Exchangeable Sodium and Crop Yields in the Punjab Soils and a New Method of Characterising Alkali Soils. Punjab Irrigation Research Institute, Research Publication Vol. IV, No. 5.	A. N. Puri . . .	Superintendent, Government Printing, Punjab, Lahore.
A Simple Method for Determining the Reaction and Titration curves of Soils. Punjab Irrigation Research Institute, Research Publication, Vol. IV, No. 6.	Balmokand Anand and A. N. Puri.	Ditto.
PLANT DISEASES		
The Fungi of Bombay. Bulletin No. 176 of 1934 of the Department of Agriculture, Bombay. Price As. 12.	B. N. Uppal, M. K. Patel and M. N. Kamat.	Government Central Press, Bombay.

Title	Author	Where published
PLANT DISEASES—*contd.*		
Two Common Diseases of Citrus Trees in the United Provinces (Urdu and Hindi). Bulletin No. 7. Fruit Series of the Department of Agriculture, United Provinces.	P. K. Dey . . .	Government Printing and Stationery, United Provinces, Allahabad.
Ear Cockle Disease of Wheat. Leaflet No. 127 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
A Method of Prevention of Smut in *Jowar* (Revised). (English, Hindi and Marathi). Leaflet of the Department of Agriculture, Central Provinces.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Control of *Jowar* Smut (Revised). (English Marathi and Hindi). Leaflet of the Department of Agriculture, Central Provinces.	Ditto . .	Ditto.
Report on the Disease of the Coconut Palm. Leaflet of the Department of Agriculture, Travancore.	M. K. Varghese . .	The Director of Agriculture and Fisheries, Travancore.
ENTOMOLOGY.		
List of Publications on Indian Entomology, 1933. Miscellaneous Bulletin No. 5 of the Imperial Council of Agricultural Research. Price As. 9 or 1s.	Compiled by the Offg. Imperial Entomologist, Pusa.	Manager of Publications, Delhi
A Pest on Stored Paddy (English, Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 65 of the Department of Agriculture, Madras.	T. V. Ramakrishna Iyer.	Government Press, Madras.
The House Fly Nuisance and its Control with Maggot Traps (Kanarese and Malayalam). Leaflet No. 64 of the Department of Agriculture, Madras.	Ditto	Ditto.

Title	Author	Where published

ENTOMOLOGY—*contd.*

Title	Author	Where published
Insect and Fungus Pests of Stored Paddy. Leaflet No. 68 of the Department of Agriculture, Madras.	T. V. Ramakrishna Iyer	Government Press, Madras.
Sugarcane Borer (Urdu). Leaflet No. 19 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Stem Borer of Sugarcane. Leaflet No. 22 of the Department of Agriculture, United Provinces.	Ditto .	Ditto.
Pyrilla Attack on Sugarcane (English and Hindi). Leaflet No. 23 of the Department of Agriculture, United Provinces.	Ditto .	Ditto.

VETERINARY SCIENCE AND ANIMAL HUSBANDRY

Title	Author	Where published
Agriculture and Livestock in India, Vol. V, parts 2, 3 and 4. Annual subscription Rs. 6 or 9s. 9*d*. (A bi-monthly Journal of Agriculture and Animal Husbandry for the general reader interested in agriculture or livestock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
The Indian Journal of Veterinary Science and Animal Husbandry, Vol. V, parts 1 and 2. Annual subscription Rs. 6 or 9*s*. 9*d*. (A quarterly Journal for the publication of scientific matter relating to the health, nutrition and breeding of livestock).	Ditto .	Ditto.
The Indian Veterinary Journal (The Journal of the All-India Veterinary Association). Quarterly. Annual subscription Rs. 4 or 6*s*. 4*d*. for members and Rs. 8 or 10*s*. for others.	P. Srinivas Rao (Editor)	The Editor, The Indian Veterinary Journal, 26 Wallajah Road, Madras.

Title	Author	Where published

VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*

Title	Author	Where published
The United Provinces Veterinary Magazine (English and Urdu). Monthly. Issued free to members of the U. P. Veterinary Association.	Issued by the United Provinces Veterinary Association.	Secretary, United Provinces Veterinary Association, Lucknow.
The Punjab Veterinary Journal .	Issued by the Punjab Veterinary Association.	The Editor, The Punjab Veterinary Journal, Lahore.
The Central Provinces Veterinary Journal (Quarterly).	Issued by the Central Provinces Veterinary Association	The Honorary Secretary, Central Provinces Veterinary Association, Nagpur.
Helminth Parasites of the Domesticated Animals in India. Sc. Mon. No. 6 of the I. C. A. R. Price Rs. 7-12 or 13*s*. 3*d*.	G. D. Bhalerao . .	Manager of Publications, Delhi.
Annual Administration Report of the Civil Veterinary Department, Bombay Presidency, 1933-34.	Issued by the Director of Veterinary Services, Bombay.	Government Central Press, Bombay.
Annual Report of the Civil Veterinary Department, Bengal and Bengal Veterinary College, for the year 1933-34.	Issued by the Director of Civil Veterinary Department and by the Principal Bengal Veterinary College.	Bengal Government Press, Alipore.
Annual Report of the Civil Veterinary Department, Punjab for the year 1933-34.	Issued by the Director, Veterinary Services, Punjab.	Government Printing, Punjab, Lahore.
Prospectus of the Punjab Veterinary College, Lahore, for the session 1935-36.	Ditto .	Ditto.
Syllabus of Lectures, etc., for the Diploma Course of L. V. P. (Punjab).	Ditto .	Ditto.
Report on the Veterinary Department, Burma for the year ending 31st March 1934.	Issued by the Director, Veterinary Services, Burma.	Superintendent, Government Printing and Stationery, Burma.
How to improve Cattle. Leaflet Nos. 1 and 2 (Revised). (English, Hindi and Marathi).	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Nagpur.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*concld.*		
Silage of *Uridal* or *Jhora ghas*—wild deep water paddy. (English and Assamese). Bulletin No. 7 of 1935 of the Department of Agriculture, Assam.	Issued by the Department of Agriculture, Assam.	Assam Government Press, Shillong.
Annual Report on the Civil Veterinary Department, North-West Frontier Province for 1933-34. Price Re. 1-13 or 2*s*.	Issued by the Superintendent, Civil Veterinary Department, North-West Frontier Province.	Manager, Government Stationery and Printing, North-West Frontier Province, Peshawar.
Ticks on Domestic Cattle (Malayalam.)	Issued by the Superintendent of Agriculture, Trichur.	Cochin Government Press, Ernakulam.
Our Cattle (Malayalam) . .	Ditto .	Ditto
Silage (Malayalam) . . .	Ditto .	Ditto
A brief report on the Improvement of Sheep in Mysore.	A. A. Monteiro . .	Superintendent, Government Press, Bangalore.
Feeding of Livestock. Leaflet of the Department of Agriculture, Travancore.	T. C. Kochunni Pillai .	Published by the Director of Agriculture and Fisheries, Travancore.
Annual Administration Report of the Army Veterinary Services in India for 1933-34.	Issued by the Army Headquarters, Quarter-master General's Branch.	Government of India Press, Simla.

NOTICE

Copies of the undermentioned publications are available for free distribution, provided the cost of packing and postage or railway freight is met by the indentor. Application should be made to the Secretary, Imperial Council of Agricultural Research (Publication Section), Imperial Record Department Building, New Delhi :—

1. Manual of More Deadly Forms of the Cattle Diseases in India (1903), 3rd Edition.
2. Notes on the Cattle of Mysore by A. Kristnasamiengar and Captain H. T. Pease (1912).
3. The Indigenous Breeds of Cattle in Rajputana by Major F. S. H. Baldrey (1911).
4. The Fodder Grasses of N. India, by Duthie.
5. Some experiments in the treatment of surra in camel (1913).
6. Treatment of surra in horses by means of arsenic and its derivation.
7. Cure of surra in horses by the administration of arsenic.
8. Immunization against Charbon Symptomatique by means of a single vaccine (1909).
9. Report on the experiment carried out to test the susceptibility of cattle for several diseases and on improved method of rinderpest serum preparation (1913).
10. Flax in India, by Robert S. Finlow (1918).
11. Catalogue of Ferns in the Herbarium of the Government of India at Saharanpur (1890).
12. Agriculture in India, by James Mackenna (1915).
13. Report of Mr. C. S. Marten on the Foreign Market for Indian Timber (1927).
14. Report on the extension of cinchona cultivation in India, by Lt. Col. Gage.
15. Catalogue of the "Plants of Kumaun", by Sir Richard Strachey and Duthie.
16. Report of the Proceedings of the Second Entomological Meeting (1917).
17. Report of the Proceedings of the Fifth Entomological Meeting (1924).
18. Review of Agricultural Operations in India, 1919-20 to 1921-22 and 1923-24 to 1928-29.

19. Report on the progress of Agriculture in India, 1907-09, 1909-10, 1911-12 to 1918-19.

20. Memoirs of the Imperial Department of Agriculture in India.

(*a*) Botanical Series. (*b*) Bacteriological Series. (*c*) Chemical Series. (*d*) Entomological Series. (*e*) Veterinary Series.	Most of the back numbers are available and can be supplied as far as possible.
21. Agricultural Journal of India. 22. Journal of the Central Bureau for Animal Husbandry and Dairying in India.	Ditto.

23. Notes on the collection and preservation of entomological specimens: Study of life history of insects, by Stebbing (1901).

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DAMAGE TO CROPS BY FROST

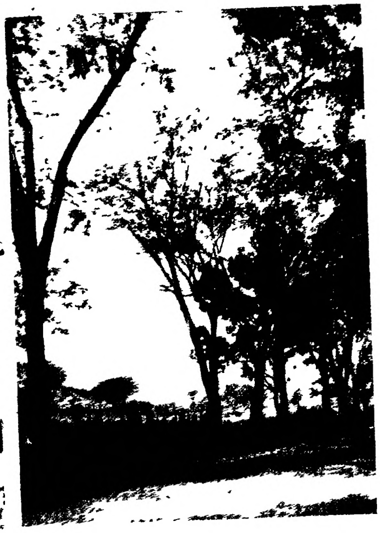

Fig. 1.—Guava plantations that were affected

Fig. 2.—Affected and non-affected bunches of grapes

Fig. 3.—Grape plantations that were affected

A corner of Manakbag (Property of Sheth Manakchand Kisandas, Uttran, Pardhade, East Khandesh) where over 100 acres are planted with citrus fruits (Santra Orange trees).